ELECTRICAL ENGINEERING

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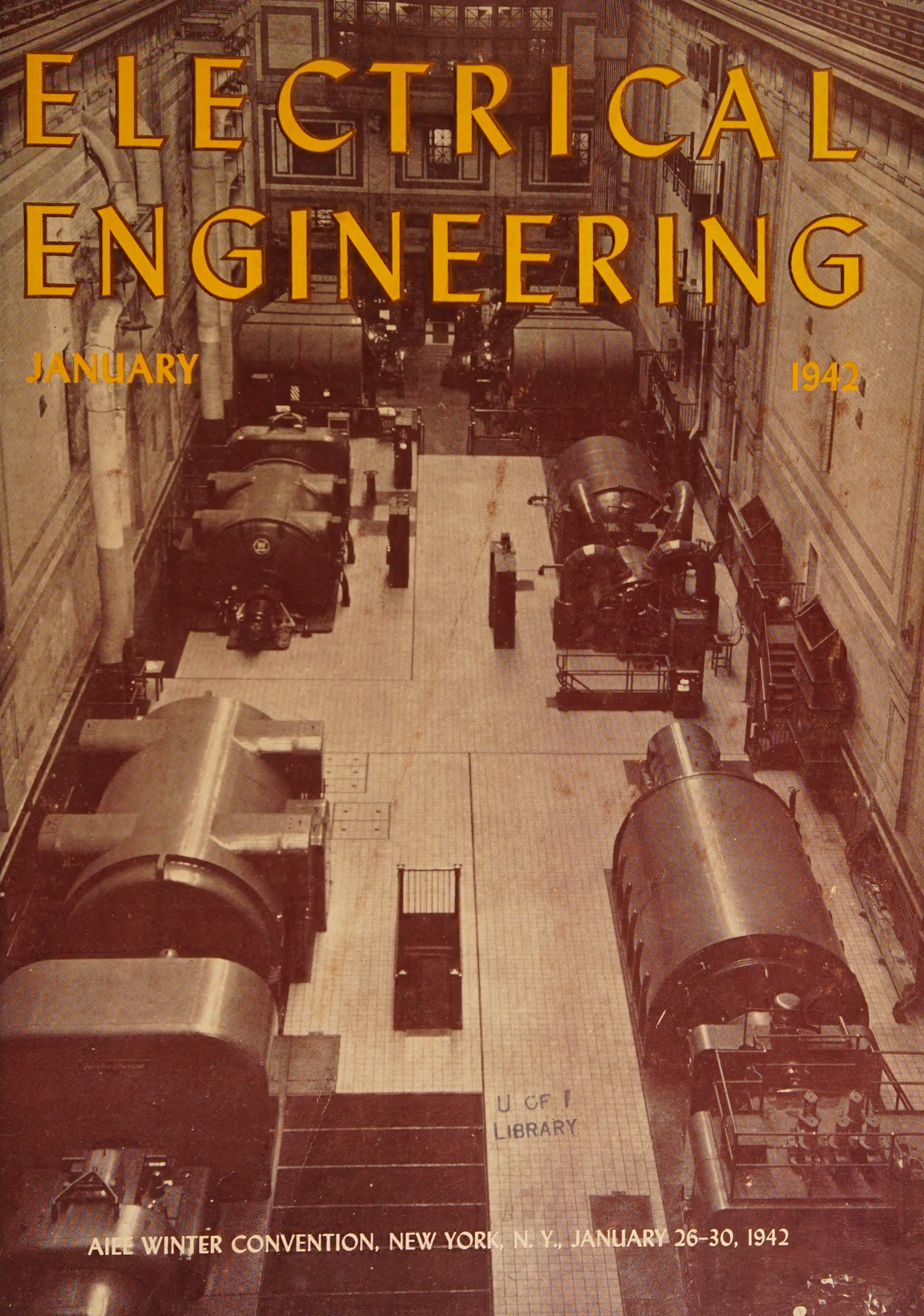

AIEE WINTER CONVENTION, NEW YORK, N. Y., JANUARY 26–30, 1942

HIGH LIGHTS • •

Power for Defense. "Today the strength of armies and navies is measured by the industrial power behind them," says the chairman of the Federal Power Commission, who continues: "The industrial power to win can only be mobilized through a gigantic plan for the utilization of all our resources, and the complete mobilization of all our resources requires tremendous amounts of electric power." Measures being taken to assure the necessary power are discussed in a series of four articles in this issue. National policy is aimed to prevent any shortage of power from hampering war production (*pages 3–7*). National planning and development of power systems are being carried out so that the new generating facilities will meet the requirements of the nation when the emergency has passed (*pages 8–17*). The electrical utilities may need to compromise some of their ideals of good service in order to meet the demands the emergency will impose upon them (*pages 18–21*). The problem before the electrical-manufacturing industry is to produce the maximum amount of equipment in the minimum possible time (*pages 22–4*).

Index, Supplement, Transactions. In order to put into effect the improved publication policy adopted in 1940, which requires that the *Transactions* volume for any year contain all approved papers and discussions for that year, some delay is entailed in issuing the combined index to the 1941 volumes of *AIEE Transactions* and *Electrical Engineering*, the December 1941 Supplement to Electrical Engineering—Transactions Section, and the 1941 annual volume of *AIEE Transactions*. A listing of the contents of the December Supplement and instructions for ordering from the limited stock appeared in the December 1941 issue, pages 593–4. The 1941 *Transactions* volume will contain all technical papers preprinted in the 12 monthly issues of *Electrical Engineering*, plus the contents of the June and December Supplements. Scheduled release dates are:

Index. With February issue of *Electrical Engineering*
Supplement. Early March
Transactions. Late March

New Dress. With this issue, *Electrical Engineering* institutes a new format, characterized by new type for text and headings, redesigned cover and table of contents page, and wider page margins. Cover title and department headings are in Lydian, a type face recently issued by the American Type Founders. Text and article headings are in Monotype Baskerville, a modern version of a type distinguished in fine printing, and especially suited to the paper now being used. The *Transactions* section, as part of the annual *Transactions* volume, retains the former type style. Comments are invited.

Winter Convention. The 1942 AIEE winter convention at New York, N. Y., has a scheduled program of more than 70 technical papers at 21 technical sessions and 4 technical conferences (*pages 35–8*). Abstracts of 46 winter-convention papers appear in this issue (*pages 42–7*); others appeared in the December 1941 issue and one in the September 1941 issue.

Insulation. Data on time rate of change of loss in impregnated-paper insulation caused by temperature and/or pressure are reported (*Transactions pages 10–13*). Ten years of development of equipment and methods for the high-voltage d-c testing of generator insulation are summarized (*Transactions pages 14–18*). Abstracts have been prepared of informal progress reports on current research presented at the recent meeting of the National Research Council's Conference on Electrical Insulation (*pages 30–4*).

Measuring Starting Torque. A method of calculating starting torque of large induction-starting synchronous motors which has advantages in convenience and accuracy over previously used methods consists of determining acceleration from a time-speed oscillogram taken from the output of a low-ripple permanent-magnet-type d-c "tachometer" generator driven by the motor (*Transactions pages 7–9*).

Paper Withheld. Because of the war situation, copies of AIEE paper 42-7, A D-C Telemeter or D-C Selsyn for Aircraft, by R. G. Jewell (A'30) and H. T. Faus (M'34) (abstracted *EE, Dec. '41, p. 598*) will not be available for distribution. Other papers may have to be withheld from advance distribution or current publication for the same reason.

FM Telegraph System. Quantitative measurements under laboratory conditions and on long operating circuits have shown that application of the principle of frequency modulation to carrier-current telegraph systems results in sufficiently improved performance to justify the slightly increased circuit complications (*Transactions pages 36–9*).

Current-Transformer Calculations. A method has been developed for calculating current-transformer performance by means of the admittance-vector locus of the secondary winding; in this way ratio error and phase angle for any burden at any power factor, turn ratio, and secondary current can be scaled or read directly from a single chart (*Transactions pages 26–30*).

Protective Relaying. Questions pertaining to the relative value of different types of overcurrent protection are answered (*Transactions pages 19–26*) and data are given concerning the performance of distribution circuits under ground-fault conditions when protected by ground relays (*Transactions pages 40–8*).

Hemisphere Economics. The role of inter-American economics in the postwar world is regarded by a representative of the Office of the Co-ordinator of Inter-American Affairs as first, one of internal development, and second, one of co-operation with the rest of the world (*pages 25–30*).

Air-Blast Breakers. Field tests on high-capacity station-type breakers have demonstrated a great reduction in fire hazard as compared with oil breakers (*Transactions pages 31–5*). Similarly a 138-kv breaker has shown up well under rigorous conditions (*Transactions pages 1–6*).

Southern District Meeting. Featured at the AIEE Southern District meeting held at New Orleans, La., December 3–5, 1941, were discussions of inter-American affairs and further discussion of post-war planning led by President D. C. Prince (*pages 38–41*).

Coming Soon. Among special articles and technical papers currently in preparation for early publication are: an article on the 200-inch telescope by Bruce Rule (A'36); an article on controlling domestic washing procedure automatically by W. J. Russell (M'37); a paper on evening courses at graduate levels regarded as a challenge to engineering colleges by Robin Beach (F'35); a report on the performance characteristics of distribution-type lightning arresters by the AIEE lightning-arrester subcommittee; a paper on electrical drives for a wide speed range by G. A. Caldwell (A'39) and W. H. Formhals (A'35); a paper on a new voltage-regulating relay with line-drop compensator by H. J. Carlin (A'41); a paper on relays and breakers for high-speed single-pole tripping and reclosing by S. L. Goldsborough (A'24) and A. W. Hill (M'41); a paper on resistance-welding transients by E. E. Kimberly (M'41); a paper on the measurement of maximum demand by P. M. Lincoln (F'12); a paper on a high-capacity circuit-breaker testing station by J. B. MacNeill (M'36) and W. B. Batten (A'28); a paper describing multichannel carrier-current facilities for a power line by P. N. Sandstrom (A'25) and G. E. Foster (A'32); a paper describing field tests on high-capacity air-blast station-type circuit breakers by H. E. Strang (M'39) and W. F. Skeats (M'36); a paper describing a static voltage regulator insensitive to load power factor by C. M. Summers (M'39) and T. T. Short; a paper on high-speed single-pole reclosing by J. J. Trainor, J. E. Hobson (M'41), and H. N. Muller, Jr. (A'37); a paper on shielding of substations by C. F. Wagner (F'40), G. D. McCann (A'38), and C. M. Lear.

Power for Defense

With the nation's defense effort suddenly exploded into what for survival must be an unlimited war effort, electric power becomes more than ever the essential keystone in the vital arch of industrial production. Thus the policies, the plans, and the procedures that have been developed for the purpose of mobilizing and co-ordinating the nation's power resources now assume commanding significance. This group of articles presents an authoritative cross section of this whole situation. National power policy is outlined by Chairman Leland Olds of the Federal Power Commission. Procedures by which this policy is being effectuated are described by Electrical Engineer Thomas R. Tate of the Federal Power Commission. A utility view is given by AIEE Past President John C. Parker, vice-president of Consolidated Edison Company of New York. Some of the problems faced by the equipment manufacturers are discussed by Vice-President Ralph Kelly of Westinghouse Electric and Manufacturing Company.

I—National Policy

LELAND OLDS

AS A NATION we are bending prodigious energies to the defense of a political system in which free men gather from time to time to guide the progress of their economic and social order. Such is the system we identify with America. Such is the system we believe to be worth fighting for. And let me emphasize that the preservation of this system requires recognition of the importance of two words, "progress" and "order".

To defend democracy we must eliminate all forces that keep it from going forward. We must make sure that it is going forward toward a concept of more nearly perfect order, realizable in terms of the broad economic trends of our time.

To defend our nation and our way of life, we must do something more than just go in for a great half-co-ordinated mobilization of our huge strength. We must achieve, through democratic processes, the same unity of purpose and planned co-ordination of effort as the dictators have been able to impose on countries across the seas.

In short, we must prove that democracy can actually work better, can achieve its ends more fully than any other form of government. And that extends to the peace that will follow, as well as to the war itself. In the process of building our defense effort we must not forget that we may win all by the force of arms and still lose democracy afterwards. We will lose it if we fail to apply the same planned co-ordination to providing a pattern of economic life which assures men the right to life, liberty, and the pursuit of happiness, interpreted, among other things, as including security of employment and a share of the livelihood our resources offer us as a nation.

We have been through a rather tough period, those of us who have realized from the beginning of the emergency how much power was going to be required. Men in a position to influence defense plans refused to think in terms of a long emergency and insisted that electric-power supply had a low priority as compared with ships and planes and tanks and guns. They did not realize how long a defense effort would be required, how great it would be, how much power would be required to make the ships and planes and tanks and guns.

TREMENDOUS AMOUNTS OF POWER NEEDED

To defend democratic institutions will require us to become the strongest nation in the world. And today, the strength of armies and navies is measured by the industrial power behind them. The industrial power to win can only be mobilized through a gigantic plan for the utilization of all of our resources, and the complete mobilization of all of our resources requires tremendous amounts of electric power.

The defense program cannot be limited to $17,000,000,000 a year, or $24,000,000,000 a year, or $36,000,000,000 a year, the figure we have set as the basis for power planning for 1943. By the time we reach 1943 our basis for defense-power planning may have been stepped up to $48,000,000,000 a year or even $60,000,000,000 a year of defense spending. And every dollar of defense-power spending requires $2^3/_4$ kilowatt-hours of electric energy.

In December 1939 we held conferences with representatives of power systems serving important defense-production areas. We estimated that the power systems

Essential substance of an address presented at a joint meeting of the AIEE Washington and Maryland Sections, Washington, D. C., November 17, 1941.

Leland Olds is chairman of the Federal Power Commission, Washington, D. C.

would have to be ready to carry a war increment of 5,000,000 to 6,000,000 kw in case of complete mobilization. Men from many areas stood up and said that could not be, because if the production of all the manufacturing plants in their areas was raised to 100 per cent there would not be demands such as we estimated.

But our 1939 estimates look small enough today compared with present estimates which place the 1943 defense load at closer to 10,000,000 kw. Billions of dollars are being invested in expansion of existing industrial plants and building of new ones. Billions more will be invested in the expansion of our productive power. Yet these expanded plant facilities would be useless without the electric power required to energize their machines and furnaces and pots.

The days are gone when men are treated with respect who say we have enough capacity to produce aluminum, copper, iron and steel, alloys, transportation, or electric power. Such talk is quite out of fashion. We now know that we have got to stretch our muscles to the utmost to catch up with the threat across the seas.

Recently, I asked the staff of the Federal Power Commission to survey the power supply of the Axis powers. Using World Power Survey figures, brought up to date on the basis of consular reports, they estimated that by 1943 the Axis powers would be in command of electric power at the rate of 200,000,000,000 kilowatt-hours a year. That compares with our country's total of 140,000,000,000 kilowatt-hours in 1940. Yet adequate power supply spells plenty of aluminum, magnesium, metal alloys, synthetic rubber, and a score of essential metal and chemical products.

We have recently seen our aluminum program expanded to envisage an ultimate production of 1,400,000,000 pounds a year, the corresponding program for magnesium calling for 400,000,000 pounds a year. And each pound of aluminum requires 10 kilowatt-hours of electric energy, while each pound of magnesium requires from 10 to 15 kilowatt-hours.

This means about 20,000,000,000 kilowatt-hours a year for defense aluminum and magnesium alone—equivalent to one seventh of all the electricity used in the country for all purposes in 1940. These metals mean bombers and pursuit planes. It is startling to go down into the southeastern states to deal with a shortage of power in systems supplying great aluminum plants and to translate the shortage of 25,000,000 kilowatt-hours a week into the equivalent 400 pursuit planes or 200 bombers a week. Then we know why we must find the power to keep the aluminum pots going 100 per cent of the time.

POWER DEMANDS MUST BE ANTICIPATED

The Federal Power Commission has been attempting to plan so that at no time will the national safety be jeopardized by lack of adequate and dependable power supply. This involves planning power supply before the defense plant that will use it has been conceived—for an industrial plant can be created in nine months to a year, whereas the additional power capacity required for its operation cannot be assured in less than two years from the date when it is planned. Whether it be in 1942, 1943, 1944, or 1945, no industrial plant needed for the expansion of our defense program must go unbuilt because there is no electric power to energize it.

Each month the Commission's defense power staff surveys the power requirements and supply situation in the 48 power-supply areas into which the country has been divided. It records the trend in demand, estimates the probable growth in demand, determines the power supply that should be planned for, and plots it against the available capacity including new units that will be installed in response to orders now on the books of the equipment companies.

Today demand is growing faster than capacity to supply demand, and we are keeping close track of the critical areas. Energy requirements for August 1941 were more than 17 per cent over those of the previous August, and in the preceding 12 months demand had increased by about 14 per cent. Of greater significance is the fact that in many areas the increases over a year ago were well above the average. Thus, in New England, exclusive of Maine, as well as in the Tennessee Valley Authority area, the demand in August 1941 was 22 per cent over that of August 1940. In the St. Louis area, demand was up 23 per cent over the previous year, while in the Bonneville northwest area the increase amounted to 45 per cent. Other significant increases were 17 per cent in the Pittsburgh area, from 16 to 18 per cent in the area served by American Gas and Electric system, including parts of West Virginia, Ohio, Kentucky, and Indiana, and 18 per cent in the Carolinas.

ENCROACHMENT ON RESERVES

A glance at the relationship between estimated peak loads for 1941 and the assured capacity available to carry those loads indicated that the year-end power situation would be very tight in at least half of the 48 areas into which the country has been divided—and this means the great majority of the more important areas from the point of view of defense industry. In many of these areas it has been necessary to cut into minimum reserves to carry the load. In some of these areas any delay in the scheduled installation of new generator units will render the situation more serious.

Projecting ourselves ahead to the end of 1942, we find that, in spite of the 3,223,000 kw of additional capacity scheduled for installation during the year, conditions will grow more critical. In fact, in 32 of the 48 power-supply areas, the net assured capacity after allowance for minimum reserves will be insufficient to carry the estimated peak loads.

This means that by the end of 1942, two thirds of the power-supply areas of the country's systems will be

forced to encroach on reserves. In 14 of these areas, with all reserves in use to carry load, there will probably be insufficient capacity, and a certain amount of curtailment may be necessary unless further regional pooling of reserves becomes possible. In another 10 of these areas the encroachment on reserves will range from 50 per cent up.

It may be noted in passing that practically the entire region east of the Mississippi River will be short of reserves, the only important surplus being in the New York metropolitan area where, with reserves of 340,000 kw, there is an indicated surplus of about 288,000 kw. This will be about enough to enable this area to carry the upstate New York deficit and provide reserves for the State, provided much heavier transmission interconnections are put in.

This situation brings us right up against a decision as to whether to plan for a reasonable minimum of additional capacity for each year through the emergency, or to follow the lead of some concerned with the defense program who are insisting that additional power units have a relatively low priority as compared with ships, planes, tanks, and guns, who would not allocate essential metals to the construction of such units, and who hold that the country can depend largely on curtailment of normal use of electricity to provide the power for essential expansion of defense production.

The Federal Power Commission has consistently taken the stand that the possible savings of power through curtailment should be reserved for emergency situations which cannot be met by planned additions to capacity, and that a minimum of additional capacity, equivalent to the ability of the equipment companies to produce land turbine generators, should be planned for each year and allotted the necessary priorities.

EFFECT OF FREEZING CAPACITY LEVELS

A number of the most important power-supply areas have been selected to illustrate the effect of freezing capacity at the levels available at the end of 1941 and then asking the areas to carry the full estimated 1943 defense loads. The results are rather striking. The curtailment of nondefense loads that would be required in these areas, assuming that no capacity is set aside for reserves to assure dependable operation, would be approximately as follows: New England, exclusive of Maine, 18 per cent; upstate New York, with allowance of 120,000 kw from the metropolitan area, 55 per cent; Pennsylvania-New Jersey pool, 14 per cent; Baltimore-Washington pool, 36 per cent; Pittsburgh area, 27 per cent; Cleveland area, 40 per cent; American Gas and Electric interconnected systems, 29 per cent; Detroit-Michigan area, 6 per cent; Chicago area, 18 per cent; St. Louis area, 26 per cent; Commonwealth and Southern southeastern areas, 50 per cent; Pacific Gas and Electric area, 40 per cent; and the Southern California area, 16 per cent.

This may, in a sense, seem a *reductio ad absurdum* of the proposal to depend upon curtailment rather than planned additions to capacity to carry the defense loads, but it reveals the need for caution. In the first place, many of the curtailments indicated would be practically impossible of attainment on a sustained basis. In the second place, if attainable, the absolute lack of reserves would enforce curtailment of essential defense loads whenever a generator or even a major transmission outage occurred.

Actually, a similar situation will exist if the need for continued expansion of the defense effort extends into 1944 and 1945 and no plans are made for the orderly installation of additional turbine-generator units for the years after 1942.

LACK OF POWER MUST NOT CURTAIL MUNITIONS

In view of the fact, which I emphasized at the start, that there are no limits to the requirements of modern war short of the maximum mobilization of our resources, we cannot afford to let such a condition develop. We cannot afford to face the possibility that a great need for expansion of munitions production will be thwarted by lack of electric power. Nor can we afford to face the possibility of excessive curtailment of nondefense use of electricity on a sustained basis.

In planning to meet the power needs of the defense program, we must also envisage the possibility that war may develop the need for large-scale substitution of synthetic for natural raw materials. This possibility renders it unsafe to count too heavily upon curtailment to carry future defense loads, for such synthetic products are likely to call for large supplies of electric power.

The Federal Power Commission, therefore, sees no reason to change the proposal it presented to the President on July 16, 1941, that we assure an orderly program for the production of steam and hydraulic turbine generators up to the capacity of equipment companies to produce such units. There appears to be a tendency in certain quarters to contend that the Commission's power program is "extravagant." Those who hold to such contentions are due for a rude awakening. We cannot afford to let the country's defense power plans be guided by the same kind of shortsightedness as the Commission had to overcome in the early days of the defense program. And we must not overlook the fact that drouths may occur in other parts of the country; that old equipment, when overworked continuously, will be increasingly subject to failure; that fuel supplies may be subject to interruption; that transmission interconnections may be interrupted; that acts of sabotage may occur; and that curtailment then will become inevitable. If adequate provision has not been made to supply growth of load, such curtailment will affect not only nondefense but also defense production.

Any proposal to reallocate the capacity of equipment companies to produce central station units, or the materials required for their production, must be based on

exceedingly cogent arguments that take into account the long range as well as the immediate requirements of a successful defense of our country against the tremendous industrial mobilization across the seas.

The Commission's approach to the problem has received sufficient publicity so that I need only recall here that it was based on defense expenditures which, by the end of 1943, will be running at the rate of $3,000,000,000 a month. It assumes that the country's energy requirements for 1943 will be 215,000,000,000 kilowatt-hours, or approximately those estimated for the Axis powers, and that this will mean a demand totaling about 43,000,000 kw as compared with an actual 1940 demand of 28,000,000 kw.

Since the preparation of the Commission's defense-power plan, there have been indications of still further expansion of the conception of what will be needed to defend America—a $50,000,000,000 a year program being the possible objective. If this materializes, the problem of assuring adequate power supply will be intensified.

We must face squarely the fact that, at best, we are not going to have in the next few years sufficient capacity to carry the load and provide an adequate margin of reserve capacity. This situation, involving as it does the pooling of reserves, the best use of all capacity, and the probability of curtailment in a number of areas, seems to pose the most difficult problem of administering a defense-power program.

CRITICAL SITUATION IN SOUTHEASTERN STATES

By way of illustration, I outline briefly the way in which the critical situation in the southeastern states was handled. In May 1941 the energy requirements of the systems serving Tennessee, Alabama, Georgia, and the Carolinas were running from 25 to 35 per cent over the requirements for the same weeks of the previous year. The TVA was actually supplying the Aluminum Company of America with about 28,000,000 kilowatt-hours a week over and above the amount required by its contract. Meanwhile, the spring runoff had been low and, as a result, the storage reservoirs were below normal.

The TVA reservoirs held about 52 per cent of normal storage, giving the system about 11 weeks of supply at the then rate of drawdown. The Commonwealth and Southern system reservoirs were at about 42 per cent of normal, representing only seven weeks of supply.

With the possibility of continued drouth, this meant a total deficit of almost a billion kilowatt-hours for these systems up to January 1942. This presented the problem of securing help through interconnections, to the extent of about 25,000,000 kilowatt-hours a week, to keep the situation from becoming critical.

The Commission called a meeting on May 20 of all the systems that might participate in a pooling of power capacity to meet the need. Simultaneously, we sent engineers into the field to visit the headquarters of the several systems to see what available steam-electric resources were not being utilized, and to arrange for transmission of such surplus energy to the points where it was needed.

Arrangements were made for starting idle steam plants in several states, others were operated at off-peak hours, and, as a result of the greater co-ordination of the power resources of 17 states, from Texas to Virginia and from Illinois and Michigan to Florida, the supply of energy to the deficit areas was increased by about 13,000,000 kilowatt-hours a week. All this was required for the expanded production of aluminum.

At the same time orders were issued for new interconnections which by the end of the year will materially increase these energy supplies.

On May 25, the Federal Power Commission, Office of Production Management, War Department, and the power systems affected by the drouth joined in an appeal to consumers to conserve electricity in the interest of defense. The Commonwealth and Southern companies laid plans for a program of voluntary curtailment of industrial load to eliminate drafts on storage.

Prior to the start of this curtailment program, the Commission made a field investigation of industrial loads in the area to determine the current and prospective energy requirements of the industries, the proportion of their output involved in the defense program, and the ways in which they could conserve power during peak periods without causing severe dislocation of employment.

The curtailment program, instituted in eastern Mississippi, Albama, and Georgia on June 16, 1941, included curtailment of ordinary street lighting, elimination of ornamental street lighting, elimination of external or show-window lighting in commercial establishments, reduction of energy use in air conditioning, and a curtailment of energy delivered during certain hours to industrial customers not engaged in essential products.

The industrial curtailment program, as finally fixed, called for a one-third curtailment between 6 a.m. and 10 p.m. on Monday through Friday and from 6 a.m. to noon on Saturday. This modification permitted almost all mills to obtain full production of goods by operating a curtailed number of day shifts and scheduling additional shifts during nighttime and weekends.

This curtailment resulted in about ten per cent decrease in day loads, some increase in night loads, a material increase in Sunday loads, and a cessation of withdrawals of water-power storage reservoirs. All storage withdrawals had formerly been necessary to meet the day loads, and there was a surplus of run-of-river hydraulic energy or steam energy available to meet increased loads during night hours or weekends.

Heavy rains in July temporarily ended the first critical period, but the Commission continued to follow the situation in detail. By October it became apparent that steps must be taken again to prevent complete drawdown of storage reservoirs before the beginning of the winter rains. The Commission held a series of confer-

ences in the area, in which representatives of power systems and state utility commissions participated. Further investigation and experiment increased the additional deliveries of surplus energy to about 20,000,000 kilowatt-hours a week, and plans were laid for a recommendation to Administrator Donald Nelson of the Supply Priorities and Allocations Board that he issue a general curtailment order as soon as it became necessary.

Time does not permit further details of the efforts of these critical months in the Southeast; but enough has been said to reveal the general outlines of the job of power administration that may have to be undertaken in other regions as the relation between power requirements and power supply becomes increasingly tight.

Certain generalizations may be made that are significant not only in terms of the defense-power job, but also in terms of the post emergency period. They are that:

1. There are possibilities in the way of co-ordination of generating facilities over wide areas that have not been realized in present system setups.

2. More high-capacity intersystem transmission interconnection is desirable and is needed to assure the maximum utilization of generating facilities, including reserves, in emergencies.

3. These interconnections are needed in part because of the difficulty of determining sufficiently in advance precisely where additional blocks of power may be needed. Power supply ought to be assured where and when it is needed, particularly in time of war.

4. With all credit to the co-operation of the many systems that have participated in working out a solution of the problem, it is beyond question that the lines of demarcation between systems appear entirely artificial in terms of wholesale power supply and even as obstacles to assurance of adequate transmission interconnection and the best utilization of generating facilities.

5. Many power systems should be revamped, not only to permit firmer interconnection with other systems, but also to make possible full utilization of existing fuel and hydraulic generating facilities within their own territories.

6. Government supervision is a necessary factor in bringing about the maximum possible co-ordination of power supply over a very extensive region.

7. Central load dispatching of power under government supervision has become necessary to secure the best possible utilization of existing facilities.

At the beginning, I suggested that to defend democracy we must make sure that it is going forward toward a more nearly perfect order, realizable in terms of the trends of our time, that we must prove democracy capable of working better than any other form of government, that we must discover a way of applying the same planned co-ordination of effort to providing a sound pattern of economic life in times of peace that has developed to assure our strength in time of war.

In these times we may recall that the efforts to assure adequate and dependable power supply during the last war bore fruit in the tremendous development of transmission during the succeeding decade, which produced our present power systems. And we may speculate on the possibility that experience in dealing with the power-supply problems of the present emergency may lead to even wider co-ordination of wholesale power supply as a separate function, with the distribution end of the business separately organized on a more nearly local basis. In any case, co-ordination and planning on a regional power-supply basis must work smoothly and effectively if we are to get through the next two or three years without power shortages that cripple our defense program. And the government must take the responsibility for such co-ordination.

This leads me to mention, in closing, the fine co-operation of the utility industry in meeting this emergency. Although utility leaders sometimes suggested rather pointedly that they thought we were exaggerating the need, they have done a splendid job in meeting the need as we conceived it. And I think the conferences of government and utility men through which the great problem has been tackled represent an important example of democratic co-operation as contrasted with dictatorship, of the democratic way of going about the solution of the even greater problems that will be upon us when the defense emergency is over.

A POSTWAR EMERGENCY

There are few responsible men who do not realize that, whatever the result of the present war may be, we are going to face after the present emergency still another emergency. Upon the way we face that other emergency is going to depend the answer to this question whether the democratic way of life is going to survive in America.

Defense of democracy means something more than bringing about the biggest production of planes and tanks and guns to meet the present threat. It means making democracy work in peace as well as in war. It means keeping democracy moving forward to assure greater security of employment for its people.

Men are already raising the question as to what we are going to do with all the electric-power generating capacity when the defense emergency is over. They will raise the same question in regard to expanded transportation facilities such as the St. Lawrence Seaway.

I answer, that, if we accept the necessity of idle generators and idle transportation facilities, we must also accept the necessity for idle manufacturing capacity. And if we accept the need for idle manufacturing capacity we must accept the inevitability of idle men. And if we accept the inevitability of idle men, the very institutions that we have defended will be in peril.

We cannot accept such things as inevitable. We must accept the responsibility for making democracy work, mighty in peace as well as in war! We must carry on from our democratic co-operation in assuring huge production for defense, to democratic co-operation in assuring the continuance of huge production to provide security and good life for all people after the defense effort is behind us. That is the supreme challenge of the defense program.

Power for Defense

II—National Program

THOMAS R. TATE
FELLOW AIEE

BRUSHING aside for the moment any technical difficulties, which are not insuperable, the problem of power-system development on a national scale becomes one of power-system economics and public policy. System planning consists in carefully working out the best means of providing and distributing power to supply the anticipated loads with adequate and reliable service in the most economical manner. System development should naturally follow system planning with such modifications and exceptions as circumstances may warrant. System planning and development on a national scale is but a name for the application to larger areas and a multiplicity of systems of the same methods and processes and similar technical and economic studies as would be adopted on an individual-system basis.

There are in the United States today (as of the end of October 1941) 174 major utility systems and 580 minor utility systems. Approximately 4,037 stations are engaged in generating electric energy, in whole or in part, for public use. Of these, 1,526 are hydroelectric plants, and 2,511 fuel-burning plants.

Of the hydroelectric plants, 11 per cent are of 15,000 kw capacity or greater, and these generate 75 per cent of all the electric energy generated by hydroelectric plants. Of the fuel-burning plants, 13 per cent are of 15,000 kw capacity or greater and generate 93 per cent of all the electric energy generated for public use by fuel-burning plants. The number of plants is not greatly different from the total number in service 20 years ago when we had 4,054; but what about their size?

The largest hydroelectric plant in service in 1920 was the Schoellkopf station of the Niagara Falls Power Company with 178,450 kw installed capacity, and that year it generated 1,240,000,000 kilowatt-hours. The largest hydroelectric plant in service in 1941 is the Boulder Dam plant of the Bureau of Reclamation on the Colorado River between the States of Arizona and Nevada. With its 865,000 kw of installed generating capacity it is probably the largest electric plant of any type in the world, and on the basis of nine months' figures its estimated output for 1941 will be 3,300,000,000 kilowatt-hours.

The largest steam-electric station in the United States in 1920 was the Waterside station (numbers 1 and 2) of the Consolidated Edison Company of New York, Inc.; its installed capacity then was 259,500 kw, and that year it generated 843,969,000 kilowatt-hours. The largest steam-electric plant in the United States and perhaps in the entire world today is the Hudson Avenue station in Brooklyn, N. Y., of the same company; it has an installed capacity of 770,000 kw, and on the basis of nine months' figures its estimated output for 1941 was 2,800,000,000 kilowatt-hours.

GROWTH IN LOADS AND CAPACITIES, 1920–40

Looking back over the past 20 years, it appears that the electric-utility industry has had to supply a load that increased by some 50 billion kilowatt-hours each ten-year period. From a total of 43 billion kilowatt-hours in 1920, the production grew to 95 billion in 1930 and to 145 billion in 1940. Based on figures for the first nine months, it is estimated at 168 billion for 1941.

A review of the year-to-year figures on production will reveal that the growth was not uniform. In some years the increase was as much as 15 per cent over the preceding year and in others substantially less; in some few years, particularly those of the great depression of 1930–34, inclusive, the production was not only less than the previous high record of 1929, but during three of those years, 1930, 1931, and 1932, the production was actually less each year than the preceding year. Beginning with 1935 the recovery in the use of electric energy was at a substantially high rate except for the year 1938 when the short business recession which began in September 1937 affected industrial production and consequently the kilowatt-hours of electric energy consumed by industries.

In 1939 business, stimulated by the expectation of war orders, reached new highs and all of the ground lost in 1938 in electric-energy consumption was rapidly recovered, the total production of electric energy reaching new high levels.

In general and except during the last few years, the growth in capacity available to supply the increasing loads has kept pace with the load, but not at the same rate. From an installed capacity of more than 14.3 million kilowatts in 1920 the increase by 1930 was over 136 per cent, to a total of 34 million kilowatts, while during the same period production increased only 118

Essential substance of an address presented at a meeting of the AIEE Washington (D. C.) Section, December 10, 1940; subsequently revised and brought up to date as of October 1941.

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per cent. However, in the second decade, 1930–40, production increased by 52.5 per cent, while the installed capacity increased only 20.6 per cent to about 42 million kilowatts. Actually, there was a surplus of generating capacity in 1930, as construction programs under way when the great depression began in 1929

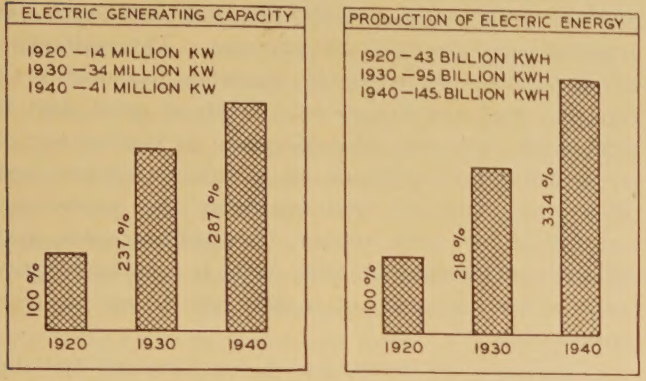


Figure 1. Electric generating capacity and production of electric energy in the United States, 1920–30–40

were continued for the most part in 1930, about 2.5 million kilowatts of capacity being added that year with practically no increase in load.

During the recovery years, with rapidly expanding loads, the larger systems have endeavored to order additional capacity sufficiently in advance to meet expected and, to a certain degree, unexpected loads. They also usually have sufficient flexibility in reserves to absorb any abnormal or sudden increases in demands. In the past few years, however, some of the smaller systems have fallen behind in this regard. At the present time (September 1, 1941), although there is on order almost 6.1 million kilowatts of new steam-turbine generating capacity and about 2.8 million kilowatts of hydroelectric generating capacity, there will be deficiencies of power supply in many areas of the country. These deficiencies are being met this fall by relying on interconnections with neighboring utility systems, by encroachment on reserves, and by asking large customers to stay off or curtail loads during the hours of maximum loads.

During the past decade and particularly at the present time, we are witnessing a change in the location of new industrial establishments. Manufacturers and the Federal Government are building new plants in inland areas nearer to raw materials, nearer to their markets, and in areas of low-cost power, lower taxes, and where opportunity is afforded for expansion or decentralization. This shift, although reducing the rate of growth in some of our large centers, is perhaps of great advantage to the nation as a whole and to our entire social economy. This shift of industrial production, and of the skilled laborers and their families along with it, is having a tremendous effect upon our power loads.

RECENT MONTHLY AND WEEKLY TRENDS

Recent monthly trends of power production for the entire United States indicate considerable increases over the corresponding months of 1940 and 1939. During the early part of 1940 our electric-energy requirements, which had started increasing the preceding September with the outbreak of the war in Europe, continued to be some 10 to 12 per cent higher than in 1939, some months showing increases of 15 per cent over the corresponding month of 1939. In the second half of 1940 the effect of the national-defense program on our electric-power requirements gradually began to appear. The utilization of electric energy within certain states has considerably exceeded the increase for the nation, which for September 1940 was only 7.2 per cent over September 1939, and for October 1940 only 9.8 per cent over October 1939. August 1941 figures exceed those for August 1940 by 17.3 per cent, while the utilization of energy in September 1941 increased to 20.4 per cent above that for September 1940. It may be noted from Table I that Washington, Tennessee, Alabama, and North Carolina showed extraordinarily large increases above September 1940 and had also showed considerable increase in that month over September 1939. Other states with remarkable increases are Ohio and Connecticut.

The weekly production of electric energy for the entire country has been running from 15 to 19 per cent ahead of the corresponding weeks of 1940 (Figure 2) and in December 1941 was expected to reach the all-time record of 3,600,000,000 kilowatt-hours in one week. In certain regions weekly production of electric energy consistently has been more than 20 per cent greater than in 1940. For example, in September 1941 production in the southern states during two weeks was 27 per cent higher than during the similar weeks of 1940. Recently, the total output of the Consolidated Electric Light and Power Company of Baltimore, Md., was reported for the week ended October 11, 1941, as being 22.7 per cent greater than the corresponding week of 1940. The American Water Works and Electric Company, whose subsidiary companies serve the industrial region around

Table I. Principal Increases in Electric-Energy Utilization Within Certain States, 1939–41

State	Per Cent Increase: Sept. 1940 Over Sept. 1939	Sept. 1941 Over Sept. 1940	Sept. 1941 Over Sept. 1939
Connecticut	12.3	16.5	30.8
Ohio	12.8	21.3	36.8
North Carolina	8.3	34.5	45.6
Tennessee	10.1	47.9	62.8
Alabama	24.8	37.3	71.4
Washington	17.4	50.6	76.8
United States	7.2	16.9	25.4

Utilization in a state is equal to generation within the state plus receipts from other states less deliveries to other states. Generation by industries for their own use is not included.

Figure 2. Weekly electric output in the United States, 1937–41

Pittsburgh, Pa., and neighboring areas, is reported for the same week to have exceeded last year's production by 25.6 per cent.

These high increases, while reflecting the effect of longer hours of use and the putting on of second and third shifts in factories, cannot but have some effect on peak loads, especially in those metropolitan areas where office building loads, stores, transportation systems, and residential and domestic requirements are likely to overlap, particularly on dark days between the hours of 4 and 7 p.m., but in most instances from 5 to 6 p.m.

These figures are cited to show the difficulty of planning system developments even in local areas during these strenuous times of rapidly mounting loads; to indicate the changes that are taking place with the advent of national-defense loads; and to illustrate the need of adequate planning to meet them and any emergency situation that may arise.

NATIONAL-DEFENSE PROGRAM

Concerning the national-defense program, it is important to note that while our defense program began to get under way about July 1940, only a very small portion of the defense products ordered under contracts awarded to privately owned manufacturing plants and assigned to Government financed manufacturing plants were in production by the end of that year. The bulk of this program went into production or construction in the early part of 1941 and is expected to attain a high rate in the following years. The defense program provides for: the expansion of our Navy to double its present capacity by 1946; a properly equipped Army of $1^1/_2$ million men; and the enlargement of our aircraft by 1,300 per cent, of our antiaircraft by 1,300 per cent, machine guns well over 2,000 per cent, and tanks and armored cars by some 2,400 per cent. The realization of this program requires labor, materials, manufacturing capacity, and electric power. While a good deal is being said concerning the adequacy or inadequacy of our skilled labor supply, of our aluminum, copper, and other raw materials, and regarding the production capacity of our steel, rubber, chemicals, textiles, and other manufacturing facilities, little is mentioned generally of the adequacy or inadequacy of our electric-power supply.

To evaluate the electric-power requirements that the production of raw and semifinished materials and the manufacture of the finished products for the national-defense program will create is obviously an important, although necessarily a complex, problem. This additional load is not being distributed uniformly throughout the country or uniformly in time. It is obvious that a major portion of this program will be carried out by existing establishments most suitably equipped to adapt themselves to the requirements of the defense program. Since the major portion of the defense program provides for products made of steel, copper, or aluminum, these types of industries will be the principal consumers of the additional electric energy, and the areas within which these industries are located will be the ones where the largest increases in the electric-power supply will have to be provided.

At the present time, the enacted defense program provides for an expenditure of $51,860,000,000 for supplies, material, and construction. Of this amount, contracts totaling $37,464,000,000 had been awarded by September 30, 1941, and $8,382,000,000 already had been expended. Supplementary to the Government's construction program for new production facilities, such as air bases, camps, defense housing, and other Army and Navy projects, are the enormous expansion programs of private industry. The power requirements of these two phases of the construction program are obviously not large, but completion of all these projects will take place in a relatively short time and also the additional electrical load will have to be supplied within a relatively short time.

The effect of the defense program and expansion of industrial capacity is shown on Figure 3. In this chart, the United States has been divided into eight regions, and for each the actual load in 1940 and the estimated load for 1943 are shown as solid black bars. Indicated also are the net assured generating capacities that were available in 1940 and that will be available in 1943,

providing there is no delay in delivery of generating equipment already ordered.

RELATION OF LOADS TO CAPACITY

In planning system developments such as the installation of generating facilities, construction of transmission lines, or interconnection of a system to an adjacent one from which capacity may be purchased or to which capacity may be sold, it is necessary to relate the past and prospective loads to the existing generating capacity or to that capacity which can definitely be considered as available for future loads. The relationship of these figures for load and generating capacity must be weighed carefully against the shape of the load curve, the duration of the peak loads, and the method by which the peaks are measured.

Consideration must be given to whether the capacity figures represent the name-plate ratings of the generators or the capacity that can be depended on at all times, and to the amount of reserve capacity provided for emergencies. Such relationships present problems to the individual-system planning department; but on a national scale where information is compiled from hundreds of sources, the relationship of load to capacity presents far more complex problems for analysis.

There is no adequate statistical method of approach to this problem on a national basis. Many comparisons have been made in which the total installed name-plate ratings of all the electric generators of utility systems was related to the sum of all of the maximum demands of these same systems. The inference drawn was that there was 30 per cent or more of reserves, or capacity available but not being used, and that this could all be put to useful work ready to produce kilowatt-hours whenever needed.

The summation of such name-plate ratings throughout the land has little bearing on the load that these same generators simultaneously may carry. A turbine generator name-plate rating may be less than its actual capacity by a proved overload ability. Likewise the name-plate rating may be considerably higher than the load that the machine can carry because expected loads or other considerations have not made it necessary to install boiler capacity sufficient to operate the generator at its rating. Condenser-water temperature limitations frequently make it necessary to consider other than name-plate ratings for comparison with loads. Hydroelectric installations seldom can produce full rated name-plate output at all times. The capability of a hydroelectric plant must be carefully computed, not from manufacturers' name plates but from hydrographs recording the stream flow during many years, from the storage available, from downstream requirements for the release of water, and from considerations of the nature of the

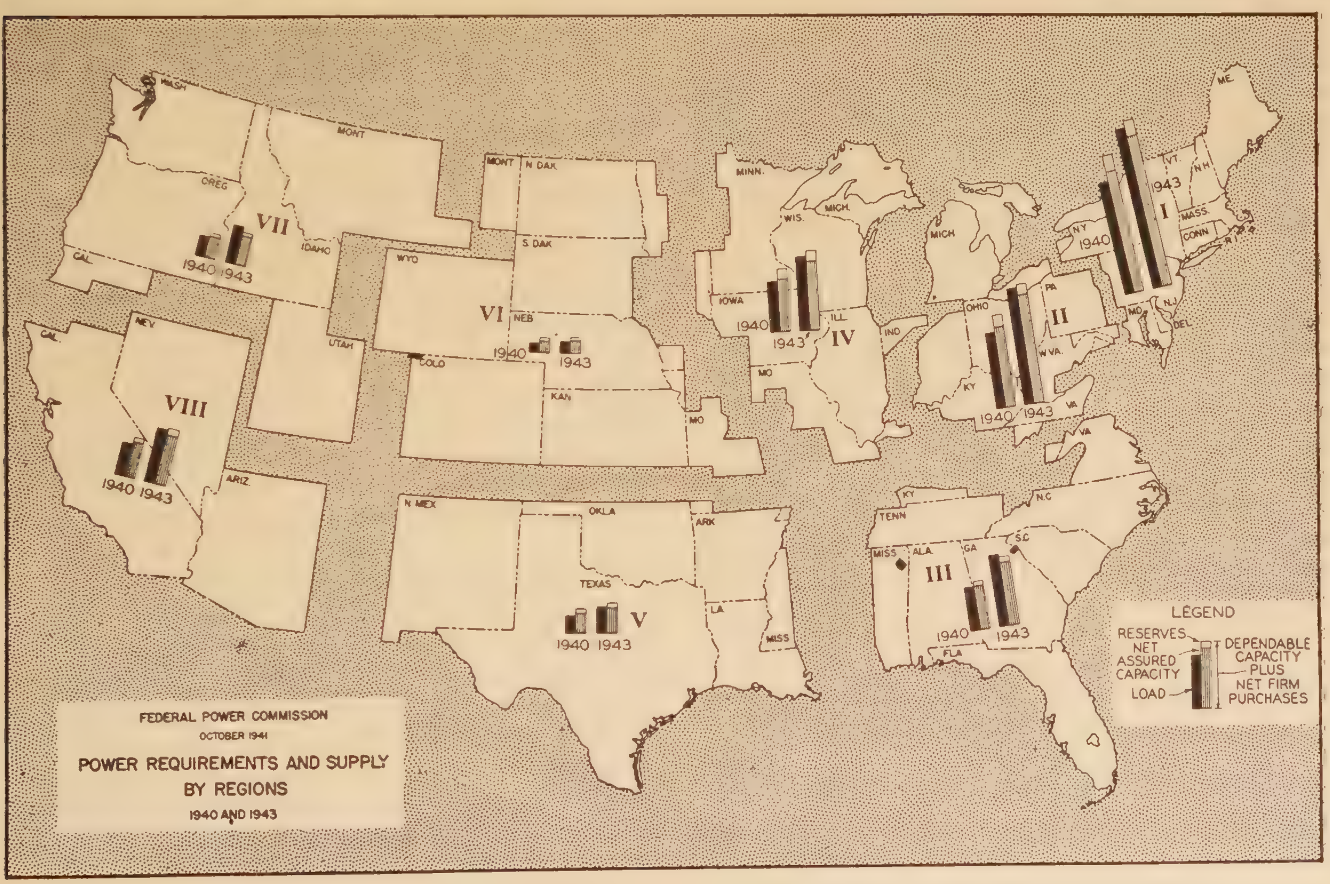


Figure 3. Electric-power requirements and supply in the United States by regions, 1940 and 1943

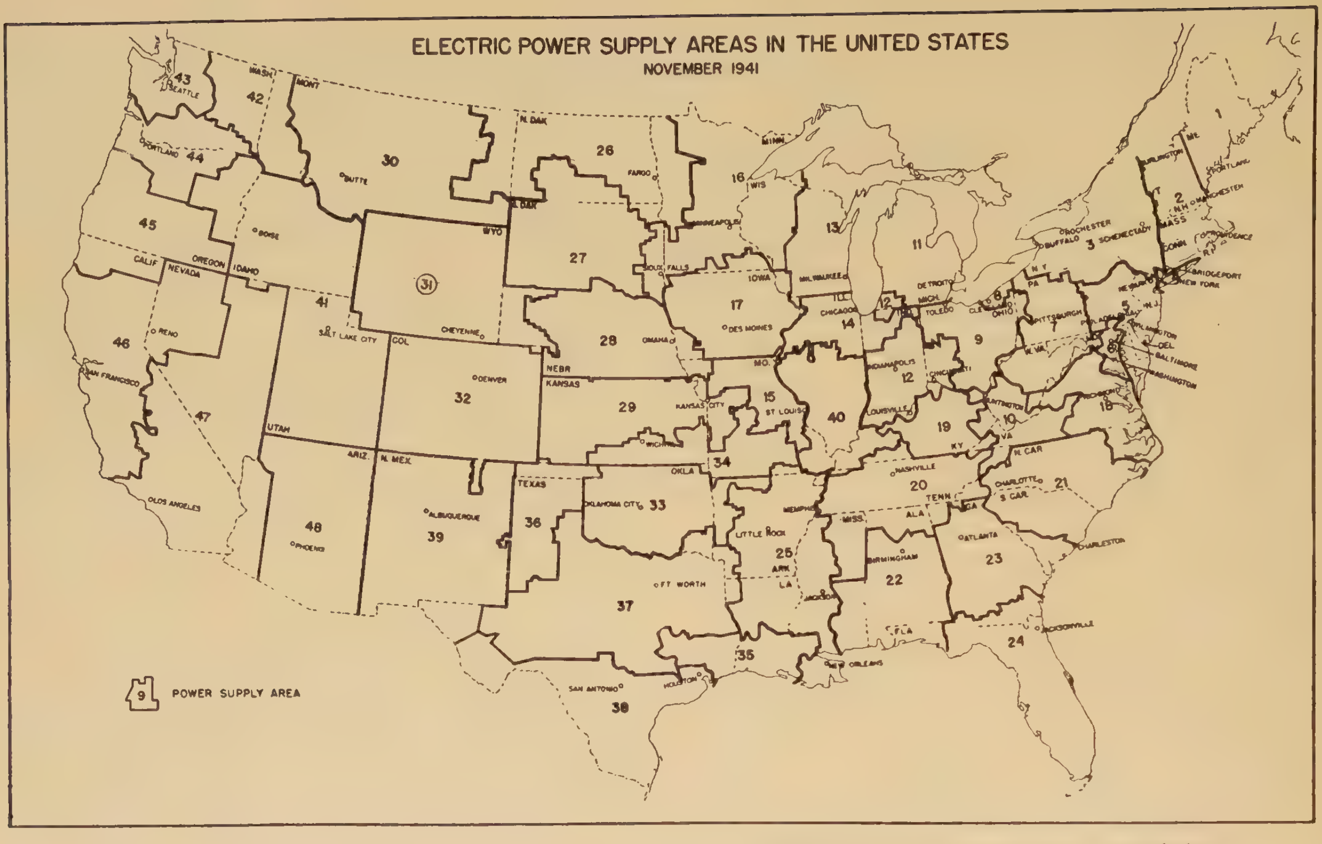


Figure 4. Electric-power-supply areas in the United States, as established by the Federal Power Commission

load for which the plant is operated so as to supply either peak capacity or base-load capacity at different seasons of the year and under varying water-flow conditions from a dry year to one of excessive water flow. As the load increases or the shape of the load curve changes, revised computations are necessary to determine the best method of operating a plant to obtain its maximum value.

In these times during which electric loads are increasing so rapidly, and in the imminent future when loads are expected to increase even more rapidly, the shape of the load curve to be anticipated is of greater moment than it has been in the past. With the award of national-defense contracts, industrial plants are expanding at an enormous rate. We see daily announcements of new plants here and there all over the United States, of existing plants adding to their capacity to consume electric power, of existing plants increasing the number of working shifts per day from one to two to three. What will be the shape of the load curve of an electric system for any given 24 hours on some dark day this winter or in 1942 no one can accurately portray. However, from an analysis of past loads, we can form a reliable opinion. The industrial component of the load served by a single system with the increment of the national-defense load is bound to increase both in magnitude and in duration. Diversities between the loads of industrial customers will decrease and approach their limits. The load-duration curve of the electric-utility system, therefore, is expected to become exceedingly sharp for those few hours representing the most peaked conditions and then to flatten out largely over the rest of its range so as to include a greater increase in energy than the increase in peak demand.

To the hydroelectric system this means that dependable capacities must be recalculated. For steam systems that rely entirely or in part on old equipment for peaking service, it requires a careful investigation to determine whether the old equipment can operate as many hours as will be required by the new peak loads. For those systems that purchase peaking capacity from their neighbors, it means a careful analysis to determine whether such peaking capacity can long be purchased in the face of the possibility of changing load-curve shapes for their neighbors as well as themselves.

POWER-SUPPLY AREAS

System planning by individual systems is all right as far as it goes, but during a period of emergency or when loads are expanding rapidly individual systems cannot place too much reliance on their neighbors unless certain that the neighboring systems actually have or will have the surplus capacity available. In order to determine whether there is available in any area surplus capacity for use in an adjacent area and the needs for each area, the United States has been divided into 48 districts or power-supply areas (Figure 4) in which the large utility

systems have been or can readily be so interconnected as to constitute a system unit in which the summation of loads may be compared with the summation of assured capacities, and in which there is only a relatively small transfer of electric energy across area boundaries.

POWER REQUIREMENTS AND SUPPLY

The national defense power staff of the Federal Power Commission is making a continuous study of the loads in each area of the country and of the capacity available and on order or under construction to meet anticipated loads. The eleventh of a series of monthly reports on "Electric Power Requirements and Supply" recently was released by the Commission. As samples of that report, the charts for power-supply areas 5, 6, 15, and 18 are reproduced as Figures 5 to 8, inclusive.

In power-supply area 5, the peak in September 1941 was 2,492,995 kw and for December, as estimated by the utility systems, 2,894,100 kw. This is moderately below the figure that the staff of the Federal Power Commission believed to be a more probable load, but it is 255,000 kw greater than normal, as shown on Figure 5. In 1943, the demand that should be planned for in this area is shown on Figure 5 to be 3,640,000 kw or 751,000 kw above normal. The net assured capacity shown on Figure 5 makes it evident that the utility systems are not planning to serve such a load and, should it be experienced, would need to add 72,000 kw of generating capacity.

In power-supply area 6, the September 1941 peak was 665,000 kw and the utility systems estimated that the peak for December would be 789,000 kw—a figure moderately below the load that the staff of the Federal Power Commission anticipated, but 73,000 kw greater than normal, as shown on Figure 6. The demand that should be planned for in this area in 1943 is shown on Figure 6 to be 1,080,000 kw or 244,000 kw above normal. The net assured capacity on Figure 6 indicates that the utility systems do not believe such a load will materialize. Should it be experienced, they would need to add 160,000 kw of generating capacity.

In September 1941 in power-supply area 15, a peak of 541,415 kw was experienced. The peak for December was estimated by the utility systems at 581,000 kw. This figure is moderately below the figure that the staff of the Federal Power Commission expected, but it is 56,000 kw greater than normal, as shown on Figure 7. As shown on Figure 7, a demand of 780,000 kw should be planned for in this area in 1943. This is 195,000 kw above normal. From the utility systems' net assured capacity on Figure 7, it is evident that the utilities are not looking forward to serving such a load and, should it be experienced, would need to add 64,000 kw of generating capacity.

The peak in September 1941 in power-supply area 18 was 277,600 kw and the peak expected by the utility systems in December was 325,000 kw. This is considerably less than the figure that the staff of the Federal Power Commission foresaw, but it is 41,000 kw greater than normal, as shown on Figure 8. The 1943 demand which should be planned for in this area is shown on Figure 8 to be 137,000 kw above normal, or 461,000 kw. That the utility systems are not planning to serve such a load is indicated by the net assured capacity shown, and, should it be experienced, the utilities would need to add 90,000 kw of generating capacity.

In the areas served by the Tennessee Valley Authority and Commonwealth and Southern Systems, the increase in monthly energy requirements in 1941 over 1940 have ranged between 20 and 28 per cent, and the increase in peak loads has ranged between 12 and 17 per cent. There is usually no problem in meeting the peak loads because during periods of low stream flow there is spare hydroelectric capacity available at most of the main river dams; the recent problem has been one of meeting the large energy requirements for the production of aluminum and other defense materials during this drought period which may, before it is over, be found to be the most severe of record. Furthermore, the storage reservoirs had not been filled during the prior winter and spring of 1940–41, so that at the normal beginning of the dry season, about the end of May, storage reservoirs were only half full—a deficiency of about 800 million kilowatt-hours.

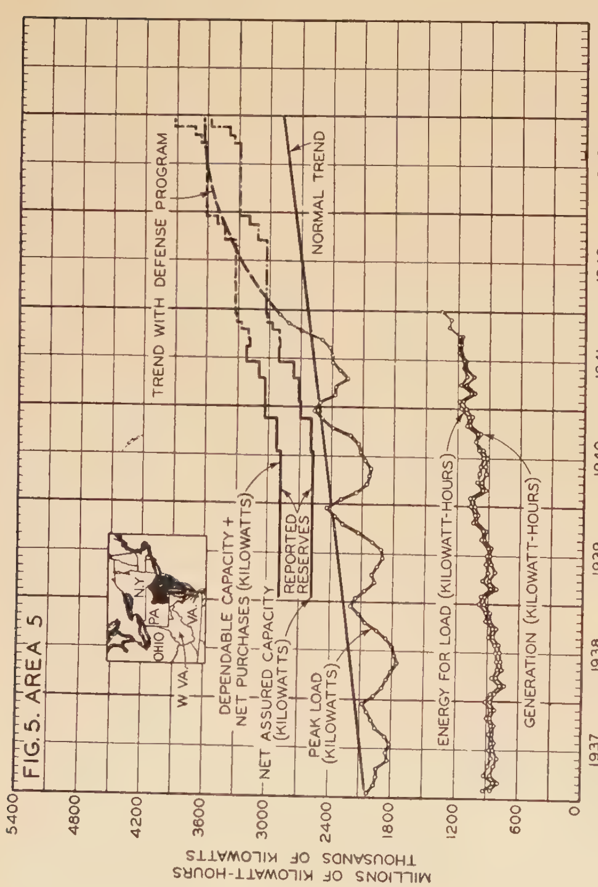
Table II. Total Electric Load and Supply, Southeastern States, for Week Ending October 25, 1941 (Areas 20, 22, and 23, Approximately)

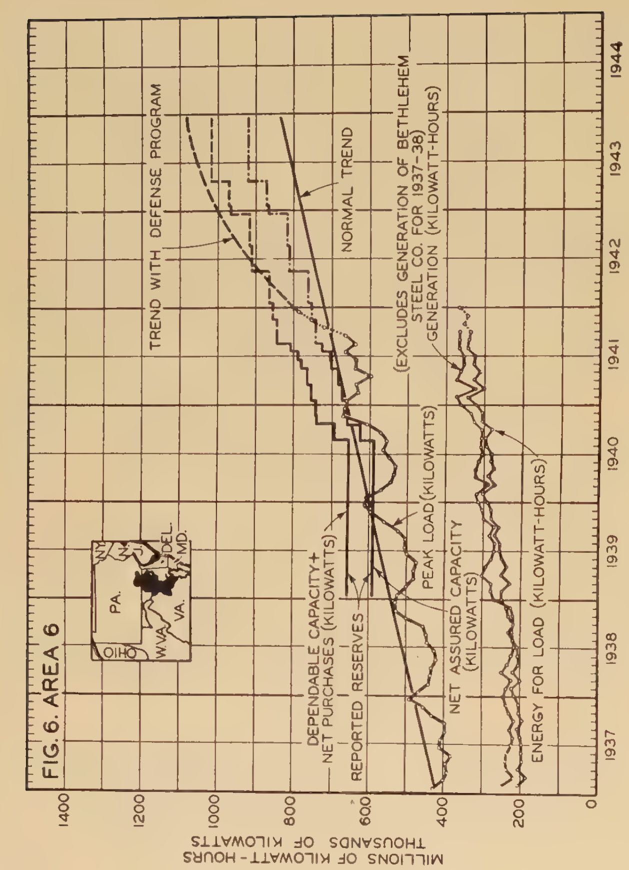
	Kilowatt-Hours
Total load	245,000,000
Receipts from outside the area	33,000,000
Energy from steam-electric plants	100,000,000
Energy from natural stream flow	30,000,000
Energy from storage	82,000,000
Total energy supply	245,000,000

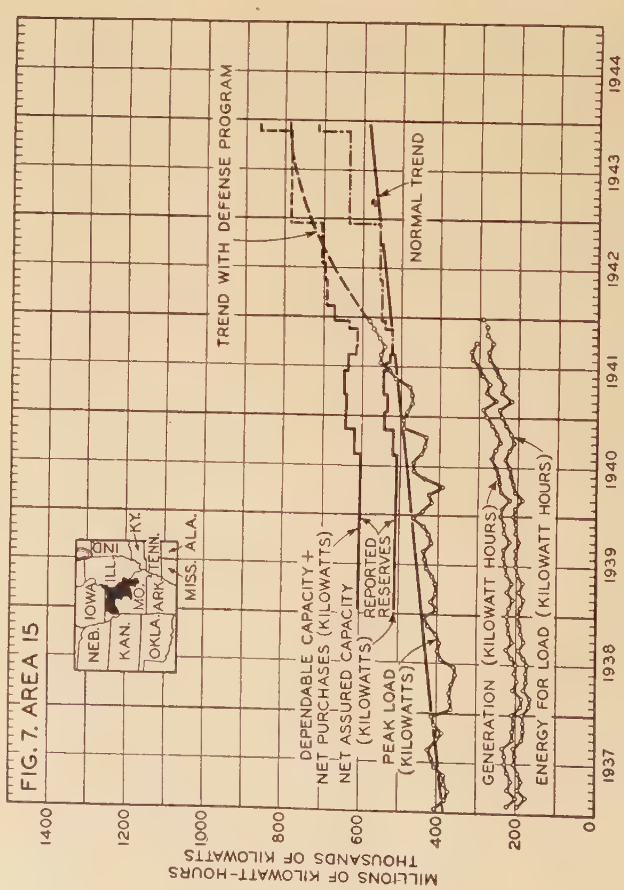
During the period from May through October 1941, the Federal Power Commission was very active in arranging for the delivery into the drought area of as much energy as possible for neighboring systems. The total of such deliveries during the period from June 1 to October 31, 1941, was over 520 million kilowatt-hours, and in the later weeks were at a rate of 33 million kilowatt-hours per week. The importance of the deliveries may be judged by noting the load and power-supply situation for the week ending October 25, when stream flow dropped to extremely low levels (Table II).

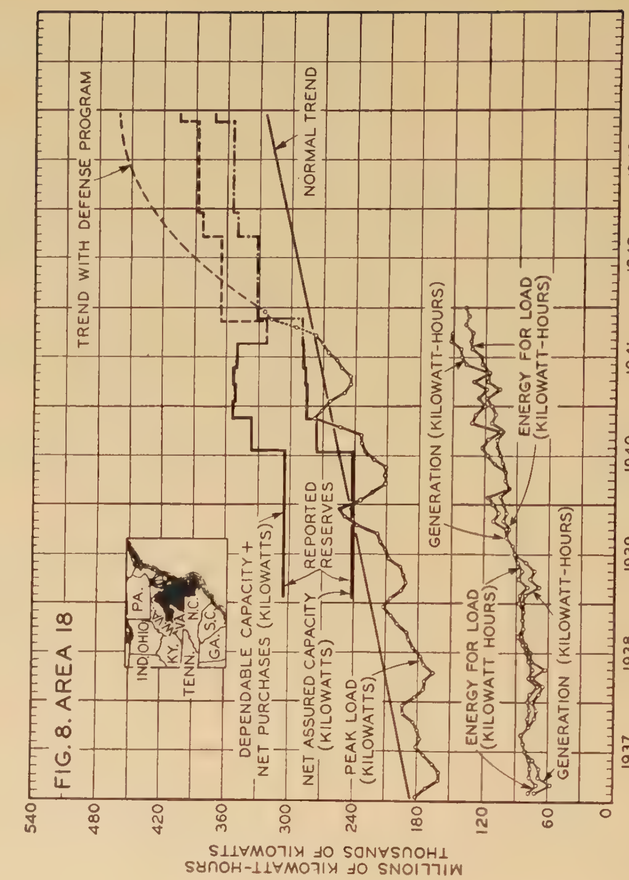
PRESENT EXTENT OF INTERCONNECTION AND CO-ORDINATION, AND NEED FOR MORE

The Federal Power Commission for several years has been engaged in studying the extent of the existing interconnection and co-ordination of electric-utility systems









Figures 5–8. Electric-power requirements and supply—areas 5, 6, 15, and 18

and of the additional benefits and economies that might be obtained by further interconnection and co-ordination. These studies are being made for each of the 48 power-supply areas into which the United States has been divided. The individual areas almost invariably include one or more substantially interconnected and co-ordinated systems, which generally serve a considerable proportion of the load within the area.

In these studies each area is considered as a self-contained unit as regards power supply and power market. Present interarea interconnections and power transactions are small in most cases. Where existing interarea interconnections and power transactions are sufficiently large, the power-supply areas are combined for further study.

The interconnection and co-ordination studies embrace all electric-utility systems having generating facilities of 2,500-kw capacity or more. In general, such systems supply from 98 to 99 per cent of the total utility energy requirements of the areas.

Factual information on each of the utility systems was assembled as a basis for the studies. These include the nature and distribution of loads; past and present trends of growth; the number, size, and age of generating units, and their capability and dependable capacity; physical and descriptive data on all hydroelectric and steam-electric plants; fuel costs, fuel consumption, production cost; location, length, and capacity of transmission lines; and the present interchanges, purchases, and sales of capacity and energy. Compiled especially for the interconnection and co-ordination studies, these data are maintained in a compact and usable form and provide sources of information upon which many other related studies may be, and now are being, based.

To determine the possible benefits that might be derived from further interconnection and co-ordination, forecasts were made of the loads that might reasonably be expected by 1945 and 1950. Consideration then was given to several possible ways of supplying those loads under, first, a continuation of present tendencies and degree of interconnection and co-ordination and, second, of a more fully interconnected and co-ordinated scheme of operation with generation in the most efficient plants and maximum utilization of existing water-power developments. Because of lack of time and of insufficient staff, consideration has not been fully given to the possibility of further development of the nation's water powers, except in a few instances of projects already built or authorized, or of projects combined with flood control and navigation.

The results of the interconnection and co-ordination studies, in general, have shown that the financial savings within the individual areas are moderate. This was to be anticipated from the nature of the boundaries of the areas. The economies, however, were important, especially as they accrued in large measure to the smaller public and private systems.

In certain areas, such as area 35 which includes portions of the States of Louisiana and Texas with 95 per cent of the load served by the Gulf States Utilities System, savings of capital expenditure of only a few hundred thousand dollars are indicated by 1950. A few areas, such as Florida, area 24, include a large number of systems not at present wholly interconnected, and thus present much greater opportunity for savings in capital expenditures and operating costs. Some emergency interconnections recently ordered by the Federal Power Commission not only will provide additional energy and capacity during the present emergency, but also, if continued after the present emergency is over, will provide large peace-time economies.

In the very important power-supply areas 5 and 6, which comprise all or most of New Jersey, Delaware, and the District of Columbia, and the eastern portions of Pennsylvania and Maryland, there are nearly one hundred electric utility systems generating or supplying energy for public use. However, three groups of systems, each well interconnected and co-ordinated within itself, and with interconnections and substantial intersystem operations with members of other groups, supply about 96 per cent of the requirements. Within this region the major utility systems now present an outstanding example of interconnection and co-ordination of operations.

In this region, a substantial saving in capital (in the neighborhood of $14,000,000) may result through further interconnection and co-ordination. This saving is not large in relation to the magnitude of the utility properties of the area, but is important when considered in relation to the savings to the smaller systems not now participating in the benefits. Obviously, the advantages of further co-ordination to the large systems serving throughout this widespread area can be only moderate. One advantage, however, which extends to all systems in the area and which is of particular significance today, is that whenever additional capacity is needed for national defense or other emergency needs a considerable block of power can be obtained quickly through interconnection and co-ordination. The pooling of reserves would liberate some of the capacity, so held, for active load-carrying duty; also the dependable capacity of the important hydroelectric plants on the Susquehanna River would be increased through connection to, and use on, the larger regional load. This latter aspect is of vital importance in a season of drought with extremely low flows, such as we are now experiencing.

In power-supply area 18, comprising most of the State of Virginia and a large section of northeastern North Carolina, about 94 per cent of the area load is served by two systems—the Virginia Electric and Power Company and the Virginia Public Service Company. There are more than 60 other electric utilities operating in the area, but only 5 have generating plants of 2,500-kw capacity or more: Richmond Public Utilities, Page

Power Company, and the municipal systems of Harrisonburg, Va., and Greenville and Washington, N. C. Substantial benefits through interconnection and co-ordination of the two large systems and of the five smaller systems are shown by the studies. Savings in capital expenditures through interconnection and co-ordination have been estimated at about $3,000,000. Annual savings in fixed charges and operation and maintenance of some $500,000 to $600,000 a year are indicated.

The studies have indicated that important savings in electric-energy production costs should be obtained in almost all areas through growth of load even without further interconnection and co-ordination. This should result from the necessary installation of new and efficient generating equipment to serve the increased load, the better loading of these facilities, the retirement of old and costly plant, and the concentration of generating equipment in large and favorably located plants. In area 18, for example, it is reasonable to anticipate that production costs, which in 1938 averaged about 3.8 mills per kilowatt-hour, will be reduced to about 2.7 mills by 1950 with the same degree of interconnection and co-ordination in both years; and that with interconnection and co-ordination the average cost may be reduced still further to about 2.5 mills per kilowatt-hour.

EXTENT OF REGION TO BE CONSIDERED FOR CO-ORDINATION

The individual power-supply areas, already largely served by interconnected and substantially co-ordinated utility systems constitute regions too small in extent for regional power-system planning. Within these restricted areas, much of the economies of load diversity and pooling of the reserves may be obtained, but even more important possibilities of economies remain. In a number of instances, adjoining areas may present contrasting pictures, one being served largely by water power and the other by steam-electric plants. The spreading of the water power throughout both areas for peaking and reserve use and the obtaining of a proper and economical balance between hydroelectric and steam-electric plant may well result in large savings in capital expenditures and annual production costs.

Within a decade or less, electric loads double those now existing must be anticipated. The public has an important interest in interconnection and co-ordination as it affects the proper development and conservation of our natural resources, the reliability of electric service, and the cost of such service. It is not enough to develop piecemeal in unrelated units to meet immediate system requirements. To meet the tremendous expansion in loads, planning must be such as to assure an ample supply of electric energy at the lowest possible cost and to utilize and conserve our energy resources.

NEED FOR SYSTEM PLANNING ON A NATIONAL SCALE

Consideration is being given today to the development of the nation's water resources in terms of drainage basins to provide for their ultimate use to the fullest extent possible. Such planning involves navigation, flood control, irrigation, water supply, water power, recreation, and other useful public purposes. Public developments of multiple-purpose projects are, in most instances, storage developments for regulation of stream flow and offer important power possibilities, both at the sites and through effect on existing and potential downstream water power. To utilize the water power potentialities to the fullest and most economical extent requires their development and operation on a co-ordinated basin-wide scale, and not to meet the unrelated requirements of individual systems or industries. Such development and operation may well be beyond the ability of individual systems and necessarily must be public or co-operative ventures. To accomplish the co-ordinated utilization and conservation of the water resources of the nation, planning on a national scale is essential.

The situation in regard to steam-electric facilities presents some similar aspects. It is eminently in the public interest that the large expansion in steam-electric plant that must occur during the next decade be such as to insure electric energy at the lowest possible cost, and that it be continuously available. The trend will be toward larger central power stations. The location of such plants must be based on careful and detailed study of many factors. The adequacy of the condensing-water supply is a primary consideration. The large volumes of water required by large stations restrict their location to points on the seaboard or along the larger rivers. Wide variations in stream flow and high summer temperatures preclude large installations on many of our rivers, particularly in the Southwest. However, some natural lakes and some artificial reservoirs, supplemented by cooling towers, have been used for condensing purposes in the arid and semiarid regions of the Southwest.

Other factors, such as fuel supply (type, location, and cost), transportation facilities, location with respect to loads, existing or necessary new transmission facilities, limit still further the desirable sites for large central power stations.

All of these factors emphasize the need of intersystem and regional planning so that the most favorable sites for steam-electric plants be developed not for local requirements, but so as best to serve the regional needs. Duplications of capacity should be avoided, and smaller plants should give way to larger and more economical units where savings will result and services will be benefited.

To achieve a proper and economical balance between steam and hydroelectric generating capacity, both must be considered on a regional and national basis, and co-ordinated through transmission facilities.

National planning today is essential to the defense program. With the rapidly growing loads, steps must be taken to see that either additional capacity be provided in time or the loads be shifted wherever possible

in the case of new plants to areas having more margin of capacity available.

The Federal Power Commission on July 16, 1941, released a power program for national defense which was the result of the Commission's studies during the past several years. The program included several steam-electric stations to be constructed by the utilities in strategic areas, supplemented and complemented by water-power developments at existing Government dams, existing private dams licensed by the Commission, or at dams either authorized or now under construction by the Army engineers in connection with flood protection work or improvements to navigation. The whole scheme was laid out to obtain the maximum co-ordination of fuel and water-power plants, to obtain maximum economy of operation with resultant savings in fuel, and is contingent upon full utilization of the production facilities of the manufacturers of hydraulic turbines, water-wheel generators, and steam-turbine generators. The capacity to manufacture the latter is rapidly being encroached upon by the demands of the Navy and Maritime Commission for propulsion units, so that water-power installations now offer the only possibility of getting additional power quickly in areas where undeveloped water-power sites are available.

During the present emergency, interconnection and co-ordination of existing facilities, releasing capacity for active load-carrying duty, will assist in meeting the rapidly increasing national-defense loads, permitting transfer of power from sections where a temporary surplus exists to others where the supply is inadequate. These will serve only as a stop-gap, however, until new facilities, both steam and hydroelectric, are developed at strategic locations. Planning must be such that these facilities will fit properly the requirements of the nation when the present emergency will have passed.

MAJOR TRANSMISSION NETWORK

In an effort to meet the emergency that would be created by our maximum national-defense effort, several means of supplying power have been considered. One of the measures explored has been the possibility of interconnecting our major centers in the northeastern industrial area.

No fixed scheme or method has been definitely determined upon, but the technical and economic feasibility of several schemes has been considered. The proposed interconnecting lines have been moved about from time to time as arguments were offered for and against certain interconnections, and as others were proposed. Various voltages have been considered from 220 kv to tie in with existing systems, to 287 kv, the voltage of the Los Angeles-Boulder Dam lines and the highest in the country today, and to a maximum of 330 kv for which equipment has been designed and could readily be manufactured.

The utilities in the eastern section of the country have been co-operating in these defense studies and have deemed the projected transmission network of sufficient merit to make an independent investigation of it. Certain preliminary studies have indicated that considerable diversity in load exists between systems, some of which are not now interconnected, and that a considerable amount of reserve capacity normally required in each area might thereby be released for actually carrying loads.

One of the schemes was to interconnect such cities as Chicago, Ill., Milwaukee, Wis., and St. Louis, Mo., in the Middle West with Detroit, Mich., Toledo, Ohio, Cleveland, Ohio, Indianapolis, Ind., Cincinnati, Ohio, Pittsburgh, Pa., and other north central cities with Buffalo, N. Y., and the industrial and strategic centers and naval bases along the Atlantic seaboard. Important economy flows of energy would take place between areas of low coal cost to areas of high coal cost and between water-power regions and fuel-burning regions during normal peace-time conditions. In an emergency, practically each important naval or war-material center thereby would have two additional sources of power supply, fed in at different ends of the existing systems, thus reducing the vulnerability of the present methods of power supply.

During the last World War we had practically no interconnections. A few were constructed then as emergency measures. General Charles H. Keller in his book, "Power Situation During the War," published in 1921, points out the need for more and greater interconnections between systems. The present emergency already has demonstrated the truth of this statement. Let us hope that before this emergency is over, consideration will be fully given to the desirability and need for stronger ties within each area and between areas. Should this emergency pass before these major tie lines can be constructed, let us look forward to their construction and operation before another emergency is upon us.

TVA Photo

Power for Defense

III—The Utility View

JOHN C. PARKER
FELLOW AIEE

ANY speaker who attempted to predict even the immediate future with reference to almost any angle of the war program would be exceedingly bold and foolish, and any statement of current facts would be quite likely to be relatively useless within a short time of utterance. The one thing of which we can be reasonably sure is that the pattern of our war program will be subject to many sudden and extensive changes frustrating forecast and altering the facts. This implies no slightest criticism of the administration of our prewar effort. On the contrary, it is a realistic appraisal of a situation inevitable in a democracy.

For long years the nations have been unaware that world revolution was in the brewing. Democracies have been unable to prepare themselves for it. Until Sunday our particular democratic nation was not fully aware that a world revolution was in process, or, being aware, in many segments hoped that we could subtantially escape the results.

Whatever we may think the best way in which our nation should meet what is happening throughout the world, it is clear that we cannot escape and are not escaping a pretty complete disturbance of our ordinary lives, and that we as engineers must make up our minds that we cannot carry on our activities in our accustomed ways.

Because we have not, as do countries under authoritarian governments, set ourselves to a program formulated without reference to the will of the people, we have been relatively unprepared with the machines and materials for offense or for defense. Lately, whatever the thought as to the method of employment of these devices, there has come about a well nigh unanimous popular will to have them and to have them in proportion to the vast extent of the interests of our country. Naturally such a change brings about intense disturbance of all the mechanism of production, and naturally too, lacking many of the basic data on which to form current judgments, there has to be a great deal of improvisation and much in the way of assumption and much in the way of correction and change.

Not all of our planning is in our own hands. In a revolutionary phase of world's development, what other nations do must in great measure set the pattern for us until such time as we take and hold an effective initiative.

Almost uniquely among the nations we have been geared to quantity production and to the attendant mechanization of production processes. We have had and have used huge quantities of the world's production of fundamental commodities and have produced for our economic processes unexampled amounts of power. Power development in this country has traditionally been forward looking, and in consequence we have been able so far to meet the needs for power created by enhanced production of goods—now for war rather than for the arts and industries of normal living. I have no doubt that the power engineers of the country will continue to supply this part of the national defense adequately; but it is clear that, just because our production is conditioned on an ample use of power, engineers in this field will have intensified problems of supply, and that, just because the materials and the mechanism of production are now being turned in enormous quantities into new fields, we shall have to meet our problems in new ways.

We cannot expect to do our power engineering in our accustomed fashion. Our present job is to be as adaptable and as resourceful as we possibly can, to review our standards of planning, design, and service in the light of present actualities, and to forget for the moment those things which are normally the desirable criteria when they come into conflict with the realities of the present.

I need not tell you that you are not today getting deliveries of turbogenerators, transmission-line material, transformers, and distribution equipment as quickly as you have done in the recent past. I suppose you are all aware that the question now is not when we can have these things, but whether we can have them at all.

As yet we have not found the means of distributing heavy steel forgings, steel plates, structural shapes, zinc, copper, aluminum, chlorine products, rubber, chromium, nickel, and the host of other materials entering into power operations in such a way as to take care of direct defense activities, imperative civilian needs, and the requirements of necessary power expansion. Such a distribution will be a process of compromise and adjustment, with many mistakes and subsequent readjustments. There will be curtailment of expansion all along the line, and we power engineers can, must, and will, on our own initiative, determine what curtailments, what substitutions

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Address presented at a meeting of the AIEE New York Section, December 10, 1941.

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we can make and at the same time meet the greater demand being placed on the power facilities of the country.

Some of the curtailment of expansion and improvement is going to be automatic in character and some will be imposed by exterior restraints. Most, it is to be hoped, can represent voluntary co-operation.

The scarcity of materials, the allocation of materials, and a shortage of workers, already felt in many lines of production, inevitably point to profound changes in housing development. There will be few large private homes, few luxury apartment buildings, few elaborate places of amusement, and a highly curtailed number of office buildings coming onto the lines of the power companies. Merchandising establishments easily enough may find themselves in the process of curtailment of power uses if the goods they have normally for sale become unattainable. Industries producing nondefense consumption goods and durable goods will find themselves using less and less power and light except as they can convert themselves to defense activities.

We may find it difficult to obtain even the usual number of renewal lamps for our homes. We may find it impossible to procure renewals for advertising signs and decorative lighting. When the electric toaster is burned out, the slice of bread may have to transfer itself to the kitchen range. Electric ranges may be found a dispensable refinement. It is probable that air-conditioning installations may have to await a period of more ready supply of materials. These are among the influences that in all probability will curtail expansion of our distribution and production systems.

Imposed from without will be other curtailments that flow in their turn from the shortage of primary materials or of semiprocessed materials. If there is not enough zinc and structural steel to go around, we must accept a program of allocation of materials proportioned to the relative needs in the different areas of the national economy: the direct war needs first, the essential civilian needs next, and the merely convenience requirements last.

I have no hope or expectation that allocations will be perfect or even permanent. The job is just too enormous for that. No group of men, however competent and however well equipped with data, reasonably could be expected in normal times to work out a perfect formula that would give full and adequate consideration to all the angles of any one use of any single material. The criterion is entirely the pragmatic one of trial and error, attempting first an allocation that seems on some sort of a thumb-rule process to be hopeful, finding that it works unexpected hardships, and modifying and modifying repeatedly until the thing comes somewhat close to creating the least over-all hardship. If this would be the case as to allocations in normal and relatively stable times, it obviously must be ever so much more the case under the rapidly changing conditions of a war program, which in and of itself is new to us all and subject to modification by exterior conditions, such as the dropping out of the French Republic from or the advent of the USSR into certain relations with our national interest or the astounding turn of events this week.

We found it easy enough to grumble that the Navy or the Merchant Marine had the first call on steel forgings, shop facilities, and bronze, to the high limitation of the production of land turbines. A mighty good argument was put up that naval ships are not worth much except as they have a merchant marine to protect; and that a merchant marine is not of much value except for the transportation of goods; and that war goods cannot be had without power facilities to make them, and that power facilities call for more land turbines. This reasoning may still be valid, but if we could only throw enough emphasis on the land-turbine end of the production program we would not have any merchant ships backed by a Navy to transport the tanks and the airplanes that we make with our electric energy, and we would not have a free nation in which to make anything.

I know that any program of adjustment as between these various requirements never will be in perfect balance. I do not think that the present program reasonably could be expected to be in balance. I am sure that the only way to find an approach to a proper balance is to try something and everlastingly to watch it to find where it is at fault and experimentally to develop correction. There is nothing fundamentally new or unusual in this; the new and unusual thing is the matter of scale and emphasis. In this country, under a system of free enterprise, individuals have from time to time created new and unusual demands on the raw-material supply and on the production facilities of our factories. These demands have not been so completely synchronized as are the demands under a war economy, nor have they individually constituted so great a proportion of the national production as may almost any single one of the war requirements.

The tempo of normal economic development, too, is of such a nature as to be evolutionary in character—almost imperceptible, with time for adaptation and with a not too brutal survival of the socially most fit commodities and enterprises. There are, as well, automatic balances in free enterprise which, in the main, have restrained undue development in one quarter at the expense of others and have brought the distribution of production into consonance with the intensity of consumer need. When two industrial products have come into competition for a given raw material, the relative willingness of the ultimate consumer to pay for one or the other commodity has determined the flow of that raw material, and price, again, has brought forth increasing supplies of raws—with mild inflationary tendencies.

A war-time economy, because of the scale, the tempo, and the synchronism of demands, cannot submit itself to the processes of uncontrolled free economy. One obvious effect of any attempt in that direction would be a vicious circle of runaway inflation with entrained

disasters. We therefore must come under a conscious and deliberate control of production and distribution—planning, observation, and correction, rather than the free day-by-day unperceived tests of the market place.

This process of cut and try is going to develop a lot of grief for us power engineers, but we will not minimize the grief by being insensitive to the needs in other areas of production. What we must do is seriously to analyze our realistic needs by standards of national defense and national defense only, and then to insist on the obvious and provable validity of our claims to consideration.

Right here we come into the field of voluntary readjustment of our engineering thinking and planning to the present needs of the nation. A distribution circuit is overloaded and the copper should be fattened up to take care of the overload. That copper can be had only by taking it from some other use. Before we ask for it should not we ask ourselves by what criterion overload is determined? Are we carrying currents in excess of a nice economic balance in distribution? That is our tough luck. This war period is making and still more will make others get along with uneconomic equipment, and we will not easily be heard if we ask for more copper to cut down the ohmic loss in our circuits.

Let us note here a principle in the economics of design, simply illustrated by the economic proportioning of conductors, but of quite general applicability. Generally, an engineer warrants higher capital expenditure for purposes of efficiency, by a nice combination of these two elements to obtain the least over-all cost of ownership and operation taking due account of load duration. The variation of the aggregate cost from the minimum is very small over quite a range of departure from the optimum design, so that no great sacrifice is made in a somewhat restricted design; indeed, it well may be that the margin of error in our fundamental assumptions as to either the amount or the duration of load is such as to invalidate an optimum selection. These considerations all point in one direction in this emergency. We will make but little economic sacrifice, at the worst, and probably will find, in the sequel, both generally and in this particular matter of conductor section, that we have served the ends of long-term economy if we content ourselves with designs we normally would deem skimpy.

Does overload demonstrate itself in an impaired voltage regulation? Well that is not very nice; but after all our criterion of service is itself a more or less arbitrary thing, and it may be vastly more important that the pounds of copper for the improvement of voltage regulation be diverted to running new and slim feeders to war industries or to the essential defense-housing projects.

It may be, however, that the voltage regulation of our feeders is such as seriously to interfere with motor starting or with the operation of control relays in production devices. That is a horse of an entirely different color. It may even be that the growth of load is menacing the continuity of the feed. That is an imperative demand for remedial reinforcement. Our engineering then becomes a question of how much reinforcement we shall undertake, using the least possible amount of material and manpower to do the job.

Minimizing our draft on the country's copper supply and the available manpower does not necessarily mean a reinforcement only adequate to the season's load. It well may be that we should project ourselves ahead a year or two, frankly recognizing a great deal of uncertainty as to what the future holds, and then make the best determination that we can so that today's reinforcement will be as much as is necessary and no more for the reasonable future requirements.

Have we been in the habit of carrying one spare power transformer at each substation? That is a great convenience. Through avoiding delays and the expense of transportation it insures a quicker replacement at each substation in the event of the loss of one transformer. A war-load increase in part of our territory calls for a new substation. Shall we equip it by stripping spares out of three existing substations, making up our minds that if any interruptions do occur we will have to take the time to transport a system spare for replacement? Service interruption will be longer under such a program and the difficulty of shifting two transformers around rather than repairing one in place may be great. Our problem is to balance transportation distances and facilities in combination with the defense significance of a longer interruption of service against the need for transformers.

One criterion of design dearest to the heart of the engineer will have to go overboard for the duration of this emergency. We cannot expect to replace older equipment with new and improved designs for the sake of efficiency alone. If we must expand, elaboration for economy cannot reasonably be asked.

To the extent that defense requirements necessitate the procurement of new machinery, new apparatus, added materials, we must use the least quantity of the scarcer materials and of skilled labor to satisfy our unavoidable needs. While, fortunately, frugal use of materials often marches hand in hand with efficiency, it is not always so.

Would we like to install a topping turbine solely to improve the heat cycle in an existing plant? That calls for heavy boiler drums, structural steel, forgings, chrome alloys, steel castings, copper for the windings, and aluminum for the saddles. Somebody else needs those materials and shop facilities and the skilled labor for a turbine installation to carry an unavoidable load increase. We will just have to wait. If, on the other hand, we need to carry added load for defense, and if that topping turbine will provide the increased capacity with a minimum imposition on the nation's defense economy, then the improvement in operating efficiency is all to the good. Indeed it offers one added attraction in that it places less burden on our fuel-transportation facilities.

We have, let us say, a predilection for low-speed machines. More capacity can be got out of a given

weight of material by the use of higher speeds, and hydrogen filling of our generators still further will increase the effectiveness of our use of materials. Our predilections will have to go by the board.

We have decided that the optimum economy in design calls for the installation of a certain size of unit. The rating that we would ask for falls at or near the bottom of the capacity the manufacturer could develop within a given frame size. Co-operation in the defense program says that we ought to buy maximum capacity within that frame size, postponing by so much the time at which next we will have to impose our requirements on the production industry, or, through interconnection, making the greater rating that we get available to a neighboring power company.

Let us assume that we have been accustomed to a liberal provision of reserve capacity on our system. Our load has grown. We need an added generating unit with its boilers and auxiliaries. It may be that we can get that added active capacity by reorganizing our ideas of reserve capacity and setting free that added unit for some other system whose reserves normally have not been liberal. I do not say that this necessarily can be done in many cases, but I do suggest that it is better that service of sorts be rendered even with a narrow margin of protection than that there be a deficiency of service in strategic portions of the defense area which now covers the entire continental United States.

We have been in the habit of running a plurality of services to important customers. Naturally we would like to keep that up; but again, if equipment and cable and pole-line hardware are hard to get, we may have to figure that a service subject to interruption and repair is better than no service at all.

We put neat embossed zinc or brass labels—I had almost said aluminum labels—on our poles for purpose of identification. The paint brush and stencil were used for a good many years, and the branding iron does a pretty permanent job. The zinc and the brass are pretty scarce materials.

We used the paint pot and brush for quite a time before we galvanized our transmission and switch structures. We can use them again. I think I would sooner have a bit of zinc on the top part of a line structure and on some of my line hardware than on the body of the tower. The steel itself for transmission may have to give way to the prehistoric wood pole—which is not at all prehistoric in many areas.

There are two schools of engineering thought in the matter of elaborate design—either for economy or for automaticity, especially in service protection. One group would surround the primary design with relays and auxiliaries to introduce into practice the best that science has to offer. The other group would contend that a rigorously simplified design, using to the utmost the inherent characteristics of apparatus supplemented by keen supervision gives the best development. Both schools have produced admirable results; neither is provably wrong. Today, with materials, shop facilities, and mechanics in extreme scarcity, we may well give up, for the time, the more elaborate designs, relying on intensification of managerial skill and alertness in supervision rather than on devices, except as a refined design may actually effect a saving of materials.

We cannot expect much in the way of new design in the war period except as war needs call for redesign to substitute more easily obtained materials for the scarcer ones. If improved designs were to be brought forward we might quickly come up against the limitations imposed by the materials and the technique of construction. Neither factory facilities nor flexibility in the selection of materials exist today to the degree consistent with much in the way of experiment on the practice scale.

Both in the major planning and in the minor detail there is a lot that we engineers can do co-operatively with the agencies of war-need production to make this job easier all around, and when we power engineers have done our part to readapt ourselves to a new and desperate condition then we can speak with no uncertain voice as to the imperative need of our power systems for the irreducible minimum of equipment and materials.

As often happens, closer co-operation in the line of duty parallels self-interest. Retrenchment of expenditure today is a patriotic duty. It is likewise the expedient thing. Some day this war will be over. No longer will we be producing battleships and a furiously expanded merchant marine, tanks, and ammunition for export to Britain, China, and Russia, bomber and combat planes for use against our enemies. The training camps again will be empty. There will not then be a smelting of steel and mining and refining of copper, a production of aluminum and synthetic rubber, an industrial mechanism on the level of the defense period. We can turn our hands and our skill again to the arts of peace, but the tempo almost inevitably will be reduced. Quite possibly there will be less need for power-production plant, transmission, and distribution than there is today. There will be more shop facilities for the production of even better turbines and boilers and condenser tubes and transformers than we now know. If we have deferred maintenance, avoided to the last degree system improvements, and above all else denied ourselves our accustomed growth in utilization, we will not find ourselves heavily loaded with embarrassing capital structure. There may be a capacity for increased consumer utilization to make good any deficiencies resultant from the cessation of war industries. We can then in orderly fashion go into a buyer's market for the highest possible quality of replacement and improvement materials, and we may find that through the presently enforced reorganization and simplification of our engineering standards we have developed a habit of designing and building more realistically than even the best engineering thought of the interim between the two wars has enabled us to do.

Power for Defense

IV—The Manufacturer's View

RALPH KELLY

THE PROBLEM before the electrical-manufacturing industry is to produce the maximum amount of equipment in the minimum possible time.

The power industry is in the middle of the greatest expansion period in its history. The weekly output of millions of kilowatt-hours has increased 25 per cent over 1939 and new records are being made weekly. Much of the expansion is outside metropolitan areas. Places like Fort Smith, Ark., Wahoo, Nebr., Yellowstone Park, Bowie County, Tex., and similar locations need large amounts of power.

The new steel expansion program is an example of the requirements of large blocks of power. The direct increase in load will be approximately 250,000 kw. When all the supplementary loads are added together a total increase of 500,000 kw of power will be required. The aluminum, magnesium, chlorine, and synthetic rubber programs require even larger totals than does the steel program.

Purchases of power apparatus in the past two years have been greater than ever before. Steam turbines amounting to 3,000,000 kw were purchased in 1940 and amounting to 4,500,000 kw this year. Waterwheel-generator purchases follow the same pattern, with 500,000 kw purchased in 1940, and double this amount in 1941.

Of the land steam turbines sold in the past two years, probably not more than 2,500,000 kw are in operation. This means that the electrical manufacturers of the country have a backlog of over 5,000,000 kw of land steam turbines. Many of our vital defense areas are in serious need of this generating capacity.

The land turbine load would be large enough by itself if there were no marine turbine business. The electrical industry is building turbines for the two-ocean navy and for our expanded merchant marine. The requirements of this marine program seem very large to us who are used to peace-time figures. If a rough total is made of all the horsepower in turbines being built for the United States Navy and the merchant marine, it will amount to something like one half of the present installed turbine capacity of the public-utility industry. Add this to the land turbine purchases of 7,500,000 kw of the past two years and you will have an idea of the job the electrical-manufacturing industry has to do.

There are also heavy demands for other types of power equipment which our industry manufactures. Orders for motors have gone up about 300 per cent since early 1940. Orders for transmission equipment have more than doubled. There is an unprecedented demand for lighting equipment, switchgear, transformers, instruments, and almost everything else that the industry produces. A large purchaser told me the other day that he had found the electrical industry the most heavily loaded of any of the industries with which he deals.

RAW MATERIALS HARD TO GET

One difficulty in producing this large load is caused by the raw material situation. Take copper, in peace times the electrical industry may use as much as 40 per cent of the United States production, while the munitions industry uses only a small amount. At the present time, the requirements of the electrical industry have increased greatly and the munitions industry has developed to the stage where it requires about one third of the available output.

Steel plate is hard to get. Electrical manufacturers use large amounts in circuit breakers, transformers, and generators. Its competitors for this material are the shipyards and the tank builders, which provide very tough competition.

These are examples of our many critical raw-material situations. Raw materials are to electrical manufacturing what the coal pile is to a utility. They are our life blood.

We have taken the position that our production program must not be slowed down by this situation. Our salvation has been that almost all our business is directly or indirectly connected with national defense.

Probably the most distressing situation before the industry today is its inability to make firm delivery dates on apparatus to many good customers who are engaged in nondefense activities. We are doing our best to acquaint customers with present-day conditions in the industry, but this is not easy with conditions changing as fast as they do.

The electrical industry is operating under the priority system. Priorities regulation number one requires that we place defense orders first in our schedule and, further-

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more, that we accept all defense orders tendered us when the facilities are available for their manufacture.

Critical materials are allocated on the basis of the importance of orders to the defense picture. We are required to keep complete records of orders and of the use of tools, and to make these records available to Government representatives upon request.

The electrical industry has very cordial relationships with the Office of Production Management. Branches have been set up with which we can deal directly. The power branch, as an example, has been most helpful.

To suggest some of the moves the industry is making to do the job that has been given it, I shall use the experience of my own company. The Westinghouse Electric and Manufacturing Company is producing more than one million dollars worth of equipment each calendar day and has the job of stepping up production to over one and a half million dollars a day next year. We have spent $60,000,000 in expanding regular manufacturing facilities, expansions being made in every plant. New plants for the Government totaling $55,000,000 have been built or are now under construction. These Government plants are constructed and operated by a newly created emergency products division, which is operated entirely apart from the regular departments of our company.

It is difficult to speed up the manufacture of large power apparatus. This requires new machine tools of the larger sizes, new manufacturing aisles, new feeder divisions, and, most important of all, top-flight machinists. Already the Westinghouse company's production of power apparatus has increased more than two and a half times over what it was in 1939, and when the new expansions get into gear we shall materially increase this volume.

It has been necessary to hire and train many thousands of new employees. Approximately 26,000 have been hired since June 1, 1940. This number represents more than one third of the total of 76,000 employees and is being increased every day.

Anyone who has hired new employees knows how green and bewildered they are when first placed in a highly specialized organization. When we began to hire this large number of people, we found it difficult to locate prospects. Advertisements did not produce results and very few worthwhile people appeared at the employment gate. We decided to recruit new employees through the medium of our older men. They circulated the word through their neighborhoods, distributed handbills we had provided and tacked them on bulletin boards in various places. The first campaign of this type brought 3,000 applicants in three days. There were only 11 skilled men in these 3,000, but we did secure enough prospects to place 800 men in training to become machine-tool operators.

In our experience it takes a minimum of two years to train an all-around machinist. However, we can take an intelligent mechanically minded high-school graduate and teach him to operate one machine fairly well in a six-months intensive training period. The vocational schools near our larger plants are working with us and have established special training courses. Many new employees are placed in these schools and receive pay from the company while taking vocational training. We have thousands of men and women in training for all types of positions.

The efficiency of these new employees is about 40 per cent but we have every confidence that this rate will improve. The quality of their work is good and the amount of defective work so small as to be negligible.

THE SUBCONTRACTING PROBLEM

Another problem is subcontracting. There is a lot of "know how" in subcontracting, particularly as power machinery does not lend itself readily to such activity. The tolerances are close and there is a large amount of specialized machining which is outside the experience of most companies. Some subcontractors are too timid and some overconfident. We have found it best to start by giving them educational orders and to have our best supervisors work with them on these. Financial help is sometimes required and the company's treasury department has assisted in such situations.

Westinghouse Photo

Yet with all our many difficulties the company has already subcontracted work to over 300 companies, and more are being added every week. In addition to subcontracting complete units and the machining of large parts, we are contracting for quantities of castings, screw-machine parts, plastics, tools and jigs, and a myriad of other parts normally made in our own feeder departments, that are required in the manufacture of power apparatus.

Another problem has been caused by the use of substitute materials. Our experience in the use of sub-

stitutes has been very much like that of a tight-rope walker performing in a high wind. We redesigned vacuum cleaners in order to make them out of plastic materials instead of aluminum, and then the chemicals for plastics became scarce. We changed from aluminum to copper and from zinc to copper, but whatever we turned to seemed to become scarce. We pull a rabbit out of a hat and then both the rabbit and the hat disappear. We have found very little help in substitute materials.

USERS AND MANUFACTURERS CAN AID EACH OTHER

Turning from production problems, there are some ways in which power machinery users and manufacturers can help each other in the present situation.

The use of standard apparatus should be encouraged by those in authority in each group. In certain shop sections the production can be increased as much as 20 per cent if strictly standard apparatus is manufactured. Almost all the minor variations that engineers require in standard apparatus are backed by sound engineering reasons, but in the present emergency the greatest good for the industry as a whole can be obtained by adhering to standard apparatus.

Special factory testing should be omitted. Most factories are manufacturing apparatus at such a rate today that any delays on the test floor caused by special tests create bottlenecks which the industry cannot afford.

This is the time to leave gadgets off apparatus. Large pieces of apparatus have been delayed unnecessarily in order to secure some special fitting or valve. When apparatus goes into the production stream in a large plant, it is in the position of an automobile in a narrow street—it must go forward. If it has to wait for a gadget, the whole procession is slowed down.

The power industry should continue its program of placing obsolete plants in active service. A friend who recently retired has been called back to work by the Government. He said that it was almost impossible for a fellow to retire these days. The same should be true of electrical machinery. I know that progress has been made in this direction, because our repair plants have been working overtime reblading and rewinding old machinery, supplying new parts, and getting machines back into service. Many old heroes are in operation today, creaking at the joints, burning up lots of fuel, but turning out kilowatts. Turbines built in 1910 and even earlier have been returned to service.

Both manufacturers and utilities must watch the metering situation very carefully. Rationing of power and flat rates do not go together. Materials must be made available for the manufacture of meters and instruments necessary to handle the present situation.

The improvement of power factor is one of the most efficient ways of obtaining increased capacity from many power systems. Capacitors should be given preference in power-factor correction, because they do not compete with generators for machine tools and manufacturing space in our heavy-machine aisles, as do synchronous condensers.

Capacitors use a small amount of aluminum foil in their manufacture, but they justify its use. One of our technical magazines recently stated that a pound of aluminum used in capacitors may save 80 pounds of copper that otherwise would be required in an electrical system.

Well-planned interconnections also may save generating capacity. Manufacturing companies can deliver transformers, circuit breakers, and substation equipment in a shorter time than it takes to deliver generating equipment.

ENGINEERING ACHIEVEMENTS

I should like to mention the outstanding performance of our engineers during this period. The great advances made in the past few years on high-speed turbines, hydrogen-cooled generators, air-blast breakers, and on special steels for transformers all are being utilized to the limit at the present time. Modern machinery uses smaller amounts of critical materials than do earlier designs and can be produced in greater volumes in the same manufacturing space. Who would have thought a year ago that the iron and copper content of a 138-kv 40,000-kva transformer could be decreased to the point that it could be shipped completely assembled and ready for connection?

It is a pleasure to observe the operation of our engineering and research departments. Despite the great load they are carrying, they find time to work on a multitude of forward-looking developments. They are not waiting for the post-war period to develop ideas, but are now creating the ideas that will insure a post-war period very rich in engineering progress.

The manufacturers have been able adequately to finance their many expansions from their own capital and with finances provided by various Government agencies. It is not so easy for public utilities to provide funds for large expansions. A review of the operations of 35 operating companies over the past ten years has shown that while their gross has increased 40 per cent, their net has decreased about 25 per cent. Electricity for home use is about the only commodity of which the price continues to fall, despite the constantly rising inflationary spiral.

Under this condition it is difficult to see how the expansion need for some of these large loads can be financed. I hope that the various regulating bodies look on this situation with some sympathy, because the need of more power for industry is too urgent to permit paralyzing restrictions on any part of the program.

In the present emergency, the manufacturers are very much aware of their responsibility to produce the equipment needed and are making an all-out effort to meet the demands placed on them.

The Potential of Inter-American Economics

CHARLES A. McQUEEN

Hemisphere defense is only the present phase in the development of long-range economic relations among the countries and peoples of the Western Hemisphere. Among the agencies set up by the United States Government to strengthen those ties is the Office of the Co-ordinator of Inter-American Affairs, of which an executive member here discusses past, present, and prospective economic relationships within the hemisphere.

THIS SUBJECT might be developed as an implication of the "good neighbor" or hemisphere-defense program, which would give it a certain takeoff, since everyone knows about the good-neighbor program. This is not merely a political or diplomatic catchword but has roots in the minds of the people of the United States and expresses their genuine interest in and sympathy for the people of the other Americas. Reciprocally, it appears to me that other American peoples have a fellow feeling for us, and that their heritage from the culture of the old regime in Europe is such as to prompt them to join in a demonstration of international policies contrasting with those enmities and aggressions which have brought misery to other parts of the world. We all know that the inter-American spirit has brought tangible results in the form of trade agreements to facilitate the interchange of products for mutual benefit and that the United States have had splendid co-operation from the other American countries in the increased supply of strategic materials employed by our industries in the effort to arrest the present attempts to deprive human beings of the various kinds of personal liberty which civilization has painfully acquired in recent centuries.

Perhaps the foregoing may not seem germane to the subject, but the defeat of what we call "Hitlerism" is a primary requisite to the development or even the survival of American economics. This development has proceeded over many years from a colonial stage to one of independence and the sustenance of an improving social life. A victorious Hitlerism, to judge from the avowed purposes of the European "new order," would return most of the American nations to a condition inferior to that of colonies. Practically all intelligent and unbiased people in the Western Hemisphere know that the united population and industrial power of Europe, representing a large domestic production not only in Europe but in the contiguous areas of Asia and Africa and constituting a powerful consuming unit, would leave only crumbs for the scattered producers in the rest of the world. It is unnecessary to say that its power would be used skillfully and ruthlessly for the exclusive benefit of the inner circle of the "new order."

We must go on the assumption that these reactionary forces will be defeated, as I have no doubt they will be, and consider inter-American economics as they exist and can be improved under freedom, good will, and benefits for all.

There was a time when our inter-American potential had a small voltage—or perhaps candle power, if the term can be used. Originally the main lines of force were latitudinal, connecting Europe with many scattered communities in this hemisphere. Once we were all colonies and our strength stemmed entirely from Europe. It is true that in comparatively early times some of these lines of force showed a curvature between what is now the United States and near-by areas such as Mexico, Central America, and the West Indies, caused by the attraction of the rapidly growing economy of the United States, which was especially favored in the area and resources open to its pioneers. In early times our ships traded with the West Indies especially, taking codfish, timber, and ice to those places, in return for tropical products, especially the makings of the rum that was so helpful in counteracting the northern winter. Our clipper ships on their way to the Far East by way of Cape Horn made stops in South America, but little trading was done; only the survival in some far southern ports of the name "Boston bar" recalls in these days some old efforts toward balancing production and consumption. Later on, as our manufacturing developed and we began to invent and improve many kinds of equipment and devices for our own use, buyers from other American countries came here and bought them because they were equally suitable to the needs of those countries, which likewise were going through the process of settlement and the broadening of industry and communications. This trade, however, was mostly passive on our part; we simply had merchandise that other people wanted, and they came and acquired it from us.

The business was handled generally by houses largely British and German, which had settled in the southern countries as traders and as proprietors of incipient industries. Many of the first foreign firms of consequence in the southern countries were British. Early in the 19th century Britain, the fount of capital and progress, sent its men all over the world, and for many years they were

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the business leaders everywhere, returning to the home country a great flood of profits that has been the foundation of British wealth and ability to survive the tremendous drains of the first World War and that which is now in progress. Later, in the '80s and '90s, the hordes of German travelers, investigators, and salesmen began to penetrate the international business domain, and by assiduous work commenced to threaten British domination of world trade. The British perhaps had come to take it too much for granted that the world was theirs commercially, and perhaps some of the later British efforts lacked the force and character of the pioneers. Be that as it may, the Germans soon were an important element in the southern countries, and their houses, many with connections in New York, accounted for much of our exports of such goods as were preferred to the German.

At this point I must call attention to a little fallacy in my approach. Although I may have seemed to suggest that inter-American economics were a matter of relations between the United States and the other American countries, that, of course, is not strictly true. Inter-American economy implies relations among all the American countries. However, trade between American countries other than the United States heretofore has been small, so that our best over-all picture of the past is obtained by the approach I have been using.

20TH-CENTURY TRADE AMONG THE AMERICAS

In presenting the voltage or wattage, or whatever the proper term may be, of inter-American commercial relations over modern years, we can begin with 1901, which is far enough back to give a starting point for our times. The average annual trade between the United States and the other American countries, being the total value of imports and exports, during the first five years of the century, was $395,000,000. This began the period of our rising foreign commerce, and fairly substantial gains were registered thereafter so that the average for the period 1911–15 was $773,000,000. This included the first two years of the World War when the outside world was experiencing and beginning to recover from the initial shock of that conflict. Beginning with 1916, rising prices, the needs of the United States for materials supplied the Allies and later for its own equipment, and the necessary acquisition from the United States of many products which the southern countries had generally bought from Europe, took the yearly average of 1916–20 steeply up to $2,146,000,000. This included the two post-war years, when private buying power everywhere was released suddenly and fantastic trade figures were recorded. In the more normal years of 1926–30, annual trade averaged $1,857,000,000, which in my opinion represents about the proper figure for conditions of world peace and reasonable prosperity. Unfortunately, at that time we were unable to hold the gains that had been made, and with the coming of the great depression the years 1931–35 showed a drop of over $1,000,000,000 per annum on the average, with a figure of $726,000,000. There was an improvement, however, in the average of 1936–40, to a figure of $1,192,000,000. During this time a large part of the world was substituting guns for butter. There was undoubtedly a very great underconsumption of goods which millions of people would have liked to buy had their economic or political organization permitted it.

These figures show plainly that commercial interchange between the United States and the southern countries, although disturbed by the many violent and unusual things that have happened since 1914, has reached a status that must mean something to practically every inhabitant of the Americas.

These trade figures show also that in the 40 years of this century there have been only 4 in which the United States has sold more to the other American countries, as a group, than it has bought from them. From 1901 to 1938, the only such year was 1921 when as a reaction from the depression of 1920 we shipped slightly more than we purchased. In the last three years, that is, 1938, 1939, and 1940, partly because of better conditions in those countries, partly because of demands for goods which Europe is no longer able to send, and partly because of reduced buying and the lower prices of raw materials after the sharp industrial decline of 1937, the United States exported more than it received. Otherwise, our role in modern times has been that of a consumer and elaborator of raw materials, and the surplus of our purchases, which in those 40 years ran to about $5,700,000,000, has played a part in the internal development of the other countries, particularly in our investments there in mines, packing houses, utilities, and other properties.

These trade figures, are really fascinating to consider. In the totals of each year since 1900, I can see the reflection of our puny panic of 1907, and the results of the recurrent fluctuations in prices and business conditions that began in 1914, some of which I have mentioned. I see also that, inevitably, rising industrial and business activity in the United States is indicated by rising imports. They are of course an effect, not a cause. It might seem offhand that prosperity is shown by increased exports, but the rise in imports comes first, then the larger exports resulting from the buying power created by our purchases.

The other countries of this hemisphere are important sources of food stuffs and raw materials. As the earliest settlements became permanent and it was no longer a matter simply of returning to Spain or Portugal with a fortune in bullion, the principal industries continued to be those that could ship their products abroad in return for the means of further development. This basic feature has persisted, even though more than a century has passed since the general severance of political ties with Europe. The needs of Europe for wheat, corn,

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cotton, coffee, sugar, cacao, fruits, meat. hides, wool, fodder, metals, and minerals have persisted and have remained an outstanding characteristic of hemisphere economy.

Since population in most regions is by no means great in proportion to area, internal trade never has become quite so important or so well organized as external commerce, although some of the countries are following the course of the United States in the gradual acquisition of a domestic purchasing power that can support a very considerable internal volume of business. To date, however, the cities have advanced more rapidly than the country regions. The leading cities, in fact, leave nothing to be desired from the standpoint of modernity, neatness, architectural quality, and size. They are fully up to the standards of modern civilization. Within a few hundred miles, however, may be country still in a stage of newness and rawness, even though it may have been settled for several centuries. It is that way because capital and solid enterprise have not yet been available to establish adequate roads, a well-financed provincial activity, or the type of living facilities that indicates a matured development.

After the War of 1914–18 the other American countries were left in a somewhat stronger position than they had attained previously. They had been shipping more freely to Europe than they can now, and at the height of the war demand there was an outlet for everything they could produce, at highly remunerative prices. Much of the froth was blown off in the post-war slump, but a distinct advance was made in national wealth, and the living conditions of the people recorded an improvement that was never completely lost thereafter.

One outcome of that war was the stimulation of ordinary manufacturing. Many goods of general consumption that formerly had been imported were then and have since been made in local factories. Sometimes local materials were available, but in general it has been the custom to utilize raw or partly manufactured material from other countries. Machinery and technical equipment are imported, since scarcely any beginning has been made in heavy industry.

The former war also gave rise to a considerable expansion of inter-American trade. The considerable dislocation of contact with Europe, and especially the blockade of the Central Powers, turned purchasing largely toward the United States, which also took larger amounts of hemisphere industrial raw materials. This is shown by the figures already summarized. I traveled around South America in 1913 and saw just what the pre-war conditions were. The farther countries, especially Brazil, Uruguay, Argentina, and Chile, showed no visible North American enterprise. Our sewing machines, typewriters, and agricultural machinery were generally used, but not our automobiles, tires, electrical material, or railway equipment. Within five years there was a vast change. Not only had our products appeared and established themselves, but the United States was directly represented by branches of many leading industries, equipped for service as well as sales. Some statements have appeared to the effect that these war trade gains were short-lived and that North American merchandise was soon supplanted by European, but such statements convey a wrong impression. The trade that went back to Europe was restricted largely to the goods or qualities of goods that we do not furnish competitively. In the automotive, electrical, office equipment, and machinery lines inter-American relations have held firmly.

As a result of the gradual fortification of their position, the other American republics came through the depression of the '30s in relatively good shape. They suffered very hard times and their business was greatly reduced, but after 1932 when the bottom had been reached and passed, they recovered quickly. Some countries within three or four years had attained as wholesome a prosperity as had ever been recorded in their history.

EFFECTS OF THE PRESENT WAR

The immediate reaction suffered at the outbreak of the present war was not as severe as that which came in 1914. The tendency was to remember the trade bonanza that began in 1916, and you may recall that in the last quarter

of 1939 there was a speculative flurry in commodity prices, originating in the theory, or perhaps the hope, that there would be a repetition of heavy consumption in Europe. This phase soon flattened out, and when the real character of the war became evident with the invasion of France, Belgium, and Holland in the following May, very serious concern replaced those expectations. Soon thereafter the idea of inter-American co-operation or the plan of hemisphere defense and solidarity was conceived, resulting later in the year in the establishment of what is now the Office of the Co-ordinator of Inter-American Affairs, as an agency to direct the program, and to co-ordinate it with the activities of existing Government organizations.

With the lessons of the other war in mind, it was not so difficult as it might have been to foretell what might be needed.

To provide possible financial support of an emergency character, the Export-Import Bank was provided with funds that could be loaned under certain conditions for the encouragement of trade and the support of currencies. As it has turned out, much less financial assistance has been required than might have been expected; the reports of the Export-Import Bank indicate that many commitments have been unused so far, and that advances have been repaid punctually. The successful conduct of this institution makes it appear that if greater financial operations are required in the future, a way has been found to handle them.

As a further means of counteracting a sudden depression, various agencies of the United States Government participated in the purchase of Latin-American materials in fairly large quantities. As it has turned out, these supplies have come in very handy, making shortages less serious than they otherwise would have been.

Bearing in mind the shipping difficulties of 25 years ago, attention was paid from the beginning to the question of tonnage supply. There now are more American ships in operation in the Western Hemisphere than before the war, and although they do not make up for the missing European tonnage, they have provided a sufficient capacity to take essential goods in both directions.

These are some of the high lights of the emergency. There have been other economic problems, especially that connected with the supply of essential materials for the industries in the other countries, as well as for replacement of machinery and equipment. Even though many of these articles are controlled or are in reduced supply because of our defense program, the people of the United States have generally accepted the idea that the necessary wants of the other American countries must be supplied. Procedures for accomplishing this are as yet imperfect but are being improved.

The present inter-American program really centers about two bodies, the Office of the Co-ordinator of Inter-American Affairs and the Inter-American Development Commission. The Co-ordinator's office is concerned particularly with the part which the United States can play in the improvement of hemisphere relations, while the Inter-American Development Commission is a body set up by all the American republics as an instrumentality for longer-term planning and the execution of projects that will expand and diversify the economy of the different countries. The Commission has appointed in every capital a committee composed of men of high standing and knowledge of practical affairs to advise on feasible developments. Many of these men hold official positions of responsibility so that the program has a semi-official aspect, which means that the tendency toward collective rather than individual promotion of industry is recognized. Whether this will be a permanent feature of American progress is uncertain, but the natural timidity of private capital during times of war, or its unwillingness to pioneer under abnormal conditions, has made it practically necessary to have at least a temporary link between Government and enterprise.

While the war conditions have caused heavy buying by the United States of many industrial materials, this is not generally regarded as a permanent trade. The Inter-American Development Commission, on the other hand, affords a means for the consideration and, if approved, the promotion of longer-range projects that may have a permanent effect. The second step, after preliminary approval of a certain idea, is the technical examination of the project by experts. That is the present stage of most of our enterprises now under consideration.

Throughout the American countries a renewed exploration of resources is beginning. This will bring to light a great deal of new precise knowledge, and it is reasonable to suppose that while many results will be negative some positive discoveries of value will be made. Should the present all-out war effort continue for several years, it is practically certain that the whole of the Americas will be canvassed and examined minutely, and that the potentialities, not only in minerals but in many vegetable products, such as fibers, edible and industrial oils, and medicinal plants, will be pretty thoroughly known. It is likely that improved means of communication will be established in some regions, and that at least primary manufacture will spring up in places that now have no industrial activity. A great deal of thought is being given to methods that may contain some assurance of the lasting effect of such innovations on the localities involved.

Under present conditions, therefore, not too much hardship is being suffered by our neighbors, there is good will and a sincere desire to collaborate in meeting their needs, and thought is being given to the future. The other American republics are evincing a growing spirit of solidarity. The Western Hemisphere in this turbulent time has made all fast, and is rapidly putting itself into a position to ride through the storm.

What is the economic future of this hemisphere?

What can be done to enable the 21 parts of this intercommunicating system so to co-operate as to produce a more nearly satisfactory life for their 250,000,000 people? For this, of course, must be the objective of economics. That great body of people includes many diverse types, but the great majority, as everywhere, is composed of simple, hard-working folk who do not profess to know economics, but who are the gainers when their system is well adjusted and the sufferers when it goes wrong.

RESOURCES OF THE WESTERN HEMISPHERE

This hemisphere has a land mass with two frigid extremities, a considerable expanse of temperate area near each end, and a link of tropical regions which are of moderate size in the north but extensive in the southern section. Allowing for the capricious occurrence of mineral deposits, this segment of the earth might be expected to have a potential production of almost every useful material, and it has.

The United States has the world's largest homogeneous consuming population, the northern anchor of hemisphere economics. The other greatest centers of population of good consuming power are in southern Brazil and Argentina, in the southern temperate area. The United States, also, is the greatest world center of manufacturing, and the source of much of the world's advance in technology. Manufacturing elsewhere is of consequence in Argentina and Brazil and is scattered throughout the other countries, though chiefly in the simple forms. This hemisphere is immensely predominant in the production of food stuffs such as wheat, corn, coffee, sugar, cacao, and many other items. It has absolutely no need of the rest of the world so far as eating is concerned, but one of its problems is to find better ways of bringing the food and its own people together. This hemisphere has plenty of mountains and mineral wealth, not only what is ordinarily found in mountainous areas but that obtained from older formations. Outside of tin and chrome, there is no mineral of which our supply is deficient. The third main economic resource, the pastoral, leaves little to be desired. The plains of the United States, of Argentina and of Mexico, the sheep ranges of Argentina, Uruguay, and the United States, probably could produce all the animal products that we need to supplement local pastures. These are only the very greatest and widest classifications of products. We do lack in this hemisphere the silk that we would like to have, and we do not produce enough rubber or quinine, in spite of the fact that these trees are indigenous to the central part of South America.

In a physical and productive sense, therefore, this hemisphere lacks little of self-containment. By full use of its material and mechanical ingenuity it could readily find reasonable substitutes for what it lacks and in the course of time develop the advanced or specialized commodities which it has obtained from the older countries.

There are drawbacks, however. They would not be especially troublesome if by some inconceivable chance the hemisphere were left entirely to its own resources. But under present circumstances they must be treated as actualities. We have 21 separate political entities, each with its political organization, its armed forces, its frontiers, its customs systems, and its inherited national feeling. In these compartments there is an arbitrary separation of productive effort and consuming power. This naturally brings about inequalities in the supply of goods and capital. Another drawback to the development of hemisphere economics is the unequal distribution of coal and oil, the sources of steam power. Some regions are almost exclusively agricultural and others mineral. The distances between complementary regions are often great and the means of transportation between them undeveloped or so costly as to preclude the economy of carriage that is taken for granted in the United States. Most of these difficulties could be surmounted if it were expedient or necessary, by the application of capital and technology. However, they may survive for a long time unless urgent political reasons for attacking them should arise.

As it happens, there is a recent instance of action to overcome some of these barriers. Recently Argentina and Brazil signed a treaty to give each other certain tariff preferences, for the declared purpose of "establishing in progressive form a regime that will permit a customs union to be reached between Brazil and Argentina." This step toward the possible fusion of the economies of the two largest nations in South America is one that nobody would have dared to predict.

THE HEMISPHERE AND THE FUTURE

Fortunately, we are not compelled to consider Latin-American economics from the standpoint of the creation of a self-contained unit, no matter how fascinating a challenge that would be to men of science, business, and finance. We may assume that in due course the hemisphere will revert to a normal relation to the rest of the world. The wise co-operation that now exists among the American countries has modified to a great extent the first effects of the exclusion of a large part of Europe, not to speak of other world areas, from our trade field. As this condition passes, the hemisphere will be called upon for vast supplies of materials needed for world recuperation. The immediate adjustments will undoubtedly be disturbing and will call for skillful handling. Nevertheless, if a lasting peace can be secured, the upbuilding of world industry and the restoration of reasonable and advancing consuming power by the world's population seem to promise better conditions than we have seen for many years.

Inter-American economics, then, will have two roles of importance—first, that of internal development, in order that the hemisphere may go forward in the creation of its particular contribution to the advance of

civilization, and second, that of co-operation with the rest of the world.

The tools of economics are technology and finance. There is a great need for both in our hemisphere. It has been generally observed that the great modern advances in technology have outstripped human ability to use them successfully. Perhaps we can devise some way to overcome this situation. It may be that we are working through it without knowing it. In the United States we seem to have a vast amount of capital. In addition to our productive capacity and the processes we now use, we may expect that present incentives will create new procedures and bring into use new products. In the words of a writer, we finally have a job that is big enough, the accomplishment of which will endow us with still greater power.

The potential of inter-American economics is what we wish to make it.

NRC Conference Reviews Insulation

The current status and present trend of research in various subdivisions of the general field of electrical insulation were indicated in 23 progress reports presented informally at the 14th annual meeting of the Conference on Electrical Insulation of the National Research Council. A brief report of the general features of that conference, which met at Williamsburg, Va., October 30–November 1, 1941, appeared on pages 613–14 of the December 1941 issue. Through the generous and effective assistance of Thorstein Larsen (A'34) secretary of the conference, The Research Bureau, Consolidated Edison Company of New York, Inc., New York, N. Y., Electrical Engineering presents on this and the following pages author-abstracts which reflect the high lights of 21 of the 23 informal technical reports.

The Polarization Parameters of Several Solid Dielectrics and Their Changes With Temperature and Composition; *R. F. Field.* It has been shown by K. S. and R. H. Cole that the plot of loss factor against dielectric constant for a single polarization of any dielectric is a circular arc with its center depressed below the dielectric-constant axis. Three parameters are sufficient for specifying the polarization:

(1) the change in dielectric constant from zero to infinite frequency

(2) the relaxation frequency

(3) the storage coefficient defined as the ratio of the depression angle to a right angle and proportional to the ratio of the stored to dissipated energy in the polarization mechanism.

The simple dipole theory of Debye gives a semicircle for which the storage coefficient is zero. Values of this coefficient greater than zero yield much broader plots of dielectric constant and loss factor against frequency. It is also valuable to record the values of the related quantities, zero-frequency dielectric constant, infinite-frequency dielectric constant, and maximum loss factor. Values of these six parameters have been calculated from published data for three simple dielectrics, halowax, glycerol, and ice, and for three mixtures, polyvinyl chloride-diphenyl, polyvinyl chloride-tricresyl phosphate, and rubber-sulphur, all over a considerable temperature range and the last two for varying composition. The numerical values of these parameters cover an enormous range as the temperature is carried from -100 to $+200$ degrees centigrade. The addition of sulphur to rubber increases the numerical values of all the polarization parameters except infinite-frequency dielectric constant and relaxation frequency. The former is essentially unchanged, while the latter decreases greatly. Abrupt discontinuities occur in all parameters except zero-frequency dielectric constant at temperatures which increase with the sulphur content. Similar changes have been reported in some of the physical properties of the material.

ϵ' and ϵ'' Measurements at From 1 to 50 Megacycles by Susceptance-Variation Method; *S. I. Reynolds.* The susceptance-variation method of measurement lends itself as a precision tool for the determination of dielectric constant and dielectric loss, because the only standards used are specially designed precision air capacitors so constructed that their calibration can be relied on at ultrahigh frequencies for determination of capacity and conductance of a dielectric suitably placed in the circuit. Adjustable resistors and inductors, on the other hand, cannot be relied on for calibration at high frequencies, because of changes in their parameters caused by skin effect, contact resistance, and changes in effective capacitance and inductance. The present method is essentially a resonance method. The conductance of the dielectric under study is obtained as the difference in conductance with sample in and out of the circuit. The effective capacitance is similarly obtained. Empirical formulas for edge correction are applied to calculate dielectric constant. The loss factor is equal to dielectric constant times tan δ. The method has been used to measure tan δ values of 0.0001 to plus or minus 0.00005. Dielectric constant determinations are good to plus or minus one per cent. The apparatus can be used up to 100 megacycles.

An Investigation of the Dielectric Constant and Other Physical Properties of Benzene Solutions of Several Methacrylate Polymers; *Leslie Ackerman, Henry C. Ott, and Orlan M. Arnold.* The effect of the mode of preparation and degree of purification on the characteristics of methyl and ethyl methacrylate polymers has been investigated through electrical and physical measurements on their benzene solutions. The polymers, especially prepared for this investigation, were polymerized in ethyl acetate solution by the use of three catalysts, hydrogen peroxide, benzoyl peroxide, and light. The materials then were purified to two different degrees by one and four precipitations from acetone solution. The density of the solutions at 25.00 ± 0.01 degrees centigrade was, in all cases, found to be a linear function of the concentration. For the methyl derivative it is independent of the method of preparation with regard to catalyst and the density is slightly higher for the solutions of the once-precipitated material than for the four-times-precipitated. In the case of the ethyl methacrylates the light catalyzed material gave solutions of lower density than those of the hydrogen peroxide and benzoyl peroxide, which were identical. The ethyl derivatives showed the same density dependence on the degree of purification as did the methyl derivatives. Viscosity measurements made at 25.00 ± 0.01 degrees centigrade show that the degree of polymerization is greatly affected by the catalyst used in preparation of the material. As judged from the viscosity data, hydrogen peroxide produces, both in the methyl and ethyl derivatives, the largest polymer (highest viscosity) and light the smallest polymer.

The methyl methacrylate polymer is larger than the ethyl methacrylate polymer catalyzed by the same means. In all cases the viscosity is independent of the degree of purification. The dielectric constant is a linear function of the concentration, in the region investigated, for all the methyl and ethyl polymers. In the case of the methyl methacrylates the dielectric constant is independent of the method of preparation and of the degree of purification. In the frequency region studied the polymers showed small dispersion. The principal region for dielectric dispersion is evidently in a higher frequency region than that investigated for this presentation. The power factor at one kilocycle of all these polymeric solutions is less than 0.001 per cent, which was the limit of the measurements made on the bridge.

D-C–A-C Correlation in Dielectrics; *J. B. Whitehead (F'12) and G. S. Eager, Jr. (A'37).* Recently P. Böning has proposed an experimental method for correlating the a-c and d-c behavior of dielectrics. Assuming the Maxwell picture that a complex dielectric is equivalent to a parallel and series connection of pure resistances and pure capacitances, Böning computes the slope of the return-voltage curve, that is, the rise of voltage of residual charge, and derives therefrom the values of loss factor or power factor and dielectric loss. The present paper describes an experimental study of the validity of Böning's proposal. The chief experimental problem was the development of a method for obtaining the return-voltage curve which would draw no charge from the test capacitor. This was accomplished by a circuit consisting of an inverted vacuum-tube voltmeter, a suitable amplifier, and the electromagnetic oscillograph. A rapid-acting multicontact switch was necessary for the removal of the geometric charge with negligible loss of absorbed charge. Experiments were made on three capacitors, two of impregnated paper and one of glass. A good agreement was found between measured values and Böning's computed values for the glass capacitor. A wide divergence, however, was found for both impregnated-paper capacitors. This is attributed by the authors to the presence of a polarization resulting from space charges in the impregnated paper, the recombination of which is too slow to have an appreciable effect on the return-voltage curve, but which are continuously active under alternating stress. The authors conclude that the von Schweidler method is not subject to this difficulty and is simpler in application.

Effect of Aging Semiconducting Synthetic Rubber in Insulating Oil; *F. L. Downs, C. R. Boytano (A'36), and G. M. L. Sommerman (M'37).* Research on mixtures of certain types of carbon black and rubber has led to the development of rubbers having electrical resistivities from 10 to 1,000,000 ohm-centimeters. These semiconducting rubbers are used as shielding layers on rubber-insulated cables. The shielding of paper-insulated and varnished-cambric-insulated cables, however, requires the use of compounds which are oil-resisting and which might improve rather than deteriorate the electrical properties of the impregnating oil. As a result, the present investigation was begun on semiconducting compounds utilizing oil-resisting plastic and vulcanizable synthetic rubbers instead of natural rubber. Two of these semiconducting synthetic rubbers (SCSR) were studied in detail. Thin samples of the compounds were immersed in heavy cable oil and aged at 85 degrees centigrade for 12 weeks. Measurements of the physical and electrical properties of the compounds and of oil power factor were made at intervals. It was found that SCSR-A retained to a high degree its plasticity, tensile strength, and elongation. SCSR-B shrank and became hard and brittle due to loss of plasticizer, while SCSR-A swelled slowly to a limiting value of about 33 per cent. The electrical resistivity increased with aging for SCSR-A and decreased for SCSR-B. The effect of the presence of 700 square centimeters of conducting compounds in 1,200 cubic centimeters of oil on the power-factor stability of the oil was studied. SCSR-B caused the oil power factor to increase rapidly after prolonged aging, but this was due to the absorption by the oil of the compound plasticizer which had very poor dielectric properties. The presence of SCSR-A, however, had a very marked effect in maintaining a low oil power factor during aging, the power-factor increase being only about one-tenth that of the blank oil sample.

Anomalous Relation Between Dielectric Strength and Paper Density in Paper Cables; *W. A. Del Mar (F'20), J. H. Palmer (A'29), and C. N. Works (A'40).* During the past several years Doctor J. B. Whitehead has presented several papers on the effects of various elements in paper-cable design upon the dielectric strength of the insulation. The elements on which he has reported are the paper density, paper tape thickness, and impregnant viscosities. Our present investigation covers the effect of overlay between adjacent tapes on the dielectric strength of paper insulation and, more particularly, its effect on the paper density breakdown relation, to explain, if possible, Doctor Whitehead's results on the effect of paper density which seemed so contradictory to results obtained on commercial cables and to the results which cable engineers expected for this work. In order to expedite this work flat samples were used instead of cylindrical cable samples, and short-time voltage breakdowns were used instead of long-time aging tests. This work should, therefore, be considered as preliminary until checked by tests of actual cable samples. Two types of paper of contrasting densities were used. One will henceforth be called low-density paper and the other, high-density paper. Both papers were in the form of tapes three-fourths inch wide. Rolls of the tape were pre-impregnated in a factory impregnating tank, being given the same impregnation schedule as commercial solid-type cables. They were then stored under the impregnant until used. Both were made from the same basic wood pulp. The lower grounded electrode was a brass plate $10^1/_2$ inches in diameter. This was mounted in a square of bakelite, the surface of which was level with the surface of the electrode to support overhanging ends of the paper tapes. The top high-voltage electrode was a standard ASTM 2-inch brass electrode. The small size of the high-voltage electrode enabled us to make four breakdowns on each test specimen. During the test the whole assembly was immersed in oil-filled cable oil. The short time of test prevented contamination of the sample by this oil. At $33^1/_3$ per cent overlay, that used by Doctor Whitehead, the low-density paper had an average breakdown value 7.7 per cent higher than the high-density paper. The maximum deviation from the average at this point was 7.9 per cent, while the average deviation was 5.1 per cent. On the other hand, at 37.5 per cent overlay, the high-density paper had an average breakdown value 10.6 per cent higher than the low-density paper. The maximum deviation from average at this overlay was 8.9 per cent while the average deviation was 4.5 per cent. Other points had accuracies of about the same order or better.

Temperature and Electric Stress in Impregnated Paper Insulation; *J. B. Whitehead (F'12) and W. H. MacWilliams, Jr.* Little attention has been paid to the study of the long-time effect of combined high temperature and high stress in impregnated-paper insulation. The separate limits of the effect of each on the immediate values of power factor and loss have long been known. However, long-time changes in power factor and loss have been commonly attributed to gaseous ionization, oxidation, or other form of chemical deterioration. The present paper shows that in the case of one well-known insulating oil and one well-known paper comparatively small increases of temperature and stress beyond those obtaining in practice result, first, in only slight increases in power factor and loss, but over short periods of time lead to continuous and steady increases in the values of these quantities. The shape of the power-factor-voltage curves obtained is explained by the fact that the conductivity of the oil in the paper is due to relatively large ions limited in number. The oscillation of these ions causes the loss. Above a certain stress, however, the ions move completely across the oil films within a fraction of one half the alternating period, at which point the loss is interrupted until the ions move again across the film on the reverse half wave. This means that the loss component attains a maximum value with increasing stress, whereas the charging component of the current continually increases. The authors attribute the steady increase of loss under combined high tem-

perature and high stress to corresponding increases in the inherent dissociation of the oil.

The Dielectric Strength and Life of Impregnated Paper Insulation—III; *J. B. Whitehead* (*F'12*). Earlier studies of the breakdown strength of impregnated paper as related to the density of the paper, using a high-grade thin insulating oil of the oil-filled type, showed a marked decrease of dielectric strength with increasing paper density. Further studies using a heavier oil of the solid type are now reported and indicate the same type of variation; namely, a notable decrease of dielectric strength with increasing paper density. Moreover, the results indicate that the dielectric strength of the impregnated paper is noticeably higher with the thin oil than with the heavier oil. Studies have been made also of the influence of the width of the channel between successive convolutions of the paper tape on dielectric strength. Again in these experiments, the higher dielectric strength of the specimen using the thin oil over that using the heavier oil was apparent. Methods are described for detecting the initial stages of failure, and the examinations of 117 specimens have indicated clearly that in the samples studied failure usually begins in an oil channel. This conclusion has led the author to propose the accumulation and motion of space charges in the oil films and channels as qualitative explanations of practically all the results of this series of papers.

Some A-C Properties of Paper Dielectrics Containing Chlorinated Impregnants; *D. A. McLean and C. C. Houtz.* A study has been made based on a-c measurements of paper impregnated with chlorinated dielectrics over the temperature range of 0 to 130 degrees centigrade. The relations proposed by Race, Hemphill, and Endicott between properties of unimpregnated and of impregnated paper appear to be applicable to these cases if the voltage of measurement is high and the frequency low. However, as the voltage is decreased and frequency increased, barrier effects become less important and ionic impurities contribute significantly to the losses. For studying ionic impurities in this work, measurements at 1,000 cycles per second at nine volts were made. The samples consisted of capacitor windings. Both tin-alloy and aluminum electrodes were employed, bleached linen and kraft papers, and as impregnants chlorinated naphthalene, trichlorodiphenyl, and pentachlorodiphenyl. There is evidence that these chlorinated compounds decompose in contact with the metal electrodes to produce conducting material. This decomposition is influenced by all factors varied, but most strongly by the type of paper. Kraft paper, because of its high exchange capacity as compared to that of linen paper, is capable of cleaning up the impregnant to reduce the concentration of ionic impurities. The influence of electrode metal on the decomposition shows up under continuous application of high a-c potentials at elevated temperatures in that the amount of conducting material increases very rapidly when tin-alloy electrodes are used but only slowly in the presence of aluminum electrodes.

Effect of Flow in Molding on the Dielectric Constant and Loss Tangent of Rubber Filler Systems; *A. H. Scott.* The effect of flow was studied by preparing rubber specimens containing fillers in the form of sheets about six millimeters thick. The molding process was such that most of the flow was along one direction. These sheets were then cut into strips having widths approximately equal to the thickness. The strips were cut at right angles to the direction of flow, so that when they were turned through 90 degrees the dielectric constant and loss tangent could be measured along the direction of flow. The dielectric constant and loss tangent were measured by placing the strips between spaced electrodes. Two sets of measurements were made, one with the strips lying as cut between the electrodes and the other with the strips turned through 90 degrees. These values were compared with values obtained on the uncut sheet using tinfoil electrodes. It was found that specimens containing the fillers zinc oxide, titanium dioxide, ferric oxide, and aluminum oxide had dielectric constants much higher in the direction of flow than at right angles to it. Specimens containing calcium carbonate, on the other hand, showed no effect of flow on the dielectric constant and loss tangent within experimental error. A possible explanation of the large effect of flow in molding on the dielectric constant and loss tangent is that the filler was in agglomerates which were flattened out in the molding process. According to this idea the calcium carbonate was well dispersed while the other fillers were not.

Semiconducting Shields; *E. J. Merrell* (*A'41*). There was published in the *Journal* of the AIEE July 1928 (pages 534–5), an article by M. J. Lowenberg on "Braid Discharge in Single-Conductor Cable in Ducts." The article told of the failure of cotton-braided varnished-cambric cable caused by "arcs formed between the braid and the duct in which the cable was installed." Lowenberg then proceeded to tell how this trouble was eliminated by the substitution of asbestos braid for the cotton. Two elements entered into the success of this procedure: the shielding effect of the asbestos due to its partial conductivity, and the prevention of destructive effects by virtue of the noninflammability of the asbestos. Since then semiconducting shielding has had considerable vogue, but the theory of its use has never been developed for purposes of design. To aid in interpreting the meaning of 60-cycle current measurements, a theory of the electrical function performed by cable braids has been developed. This theory is based on an adaptation of the exact hyperbolic formulas for transmission lines to the circuit conditions present in a cable dielectric and braid. Characteristics predicted through applications of the theory to particular cable designs were checked by direct measurements, and discrepancies in voltage drop or temperature rise in our early measurements amounted to as much as 25 per cent in some instances. However, we had reason to believe that these errors were indicative of shortcomings in our measuring technic, such as the use of meters not compensated for internal capacitance. Null-type measurements were then employed, reducing the discrepancies to 10 per cent or less. Differences of this order are unimportant in design because of the liberal factors of safety which may be used.

The Impulse Strength of Solid and Gas-Filled High-Voltage Cables; *Andrew Gemant.* This paper is concerned with a method of computing the electric strength, in particular impulse strength, of all types of high-voltage cables. The method is based on several assumptions, and the computation is only approximate; thus the method presented is open to many improvements, to be carried out if warranted by future experimental checks. The basic assumption is that the impulse breakdown is originated by electrons that, in their turn, are emitted from the cathode. The current increases with the field intensity and, at a given limiting value, becomes unstable, leading automatically to breakdown. The method of computation thus consists of setting up the current-voltage characteristics for the different types of cables and then drawing a line parallel to the voltage axis and corresponding to the limiting current. From the intersection between this parallel line and the different characteristics, the breakdown strengths can be read from the graph. As to the value of this limiting current density, several observations on liquids and also on gases indicate an order of magnitude of 10^{-4} ampere per square centimeter. As to the current-voltage characteristics, one obtained by Baker and Boltz for toluene was taken as representative for an insulating liquid. In computing those for cables—for which there are no direct experimental data—two corrections had to be made. One takes account of the effect of the paper on the current. The second concerns the gas-filled butt spaces in gas-filled cables. In this way, numerical values could be computed that show a fair agreement with existing experimental data.

Further Tests on Low-Pressure Gas-Filled Cable; *J. A. Scott* (*M'34*). Load-cycle life tests on seven low-pressure gas-filled cables were reported. The test voltage, 85 volts per mil, was slightly above that necessary to produce ionization at 10 pounds per square inch nitrogen pressure. The first 50 to 100 load cycles produce voids by drainage and redistribution of compound, and the power factor and

ionization of the cable increase. However, the 10 pounds per square inch gas pressure prevents the destructive treeing discharge usually present in solid-type cable during the cooling cycle. These voids later fill by wax formation, and the power factor decreases again to a final stabilized value and the gaseous ionization decreases. Good life ensues. Cables treated with heavy oil reached a maximum power factor in 30 to 50 days under these test conditions and then the power factor diminished to a final reasonable and stable value. The power factor of cable treated with thin oil rose to a somewhat higher and earlier maximum but then began to stabilize and was decreasing satisfactorily at the time of the report. Casual exposure to air before leading caused a rapid early rise in power factor, but, as the exposure was moderate, stabilization did occur and good life performance resulted. One substance added to decrease the oil viscosity gave good results; three others did not.

Progress Report on Aging of Cable Insulation Subjected to Elevated Temperatures; *Thorstein Larsen* (*A'34*). Last year and the year before progress reports were presented before meetings of this conference on the results of elevated-temperature aging of high-voltage cables which has been going on in the research laboratory of the Consolidated Edison Company of New York, Inc., since November 1938, or almost three years. The principal results obtained up to this time may be summarized as follows: The different cables show great difference in stability as measured by the relative increase in overall power factor. Among the cables studied, there is one which so far has not shown the slightest increase in power factor. An earlier cable from the same manufacturer has the greatest relative increase of power factor of all those examined. In July of this year the aging at 85 degrees centigrade was discontinued and the temperature of this oven raised to 115 degrees centigrade. Samples kept at room temperature were put in this oven in addition to those that had been aging at 85 degrees centigrade up to this time. Some interesting results have been established regarding the relative rate of deterioration in the temperature range 85 to 115 degrees centigrade. If the initial almost linear increase of power factor is considered, it is found that the rate is approximately doubled for a rise in aging temperature of 15 degrees centigrade for all the cables. One of the cables shows a maximum in the power-factor curve after from 12 to 14 months aging at 100 degrees centigrade and about 28 months aging at 85 degrees centigrade.

A New Test for Evaluating Electrical Insulating Oils; *J. C. Balsbaugh* (*M'35*) *and A. G. Assaf.* The new test referred to is a limited oxidation test in which only definite amounts of oxygen are made available to the oil. This is in contrast to the more conventional tests corresponding to an open-beaker test or a test in which the oxygen is at atmospheric pressure. The tests referred to in the following have been made at 85 degrees centigrade, the electrical measurements being made at the same temperature and in the presence of copper. These tests have been made with variable amounts of oxygen ranging from a blank test in which no oxygen is made available to the oil up to and including a continuous oxidation test in which the oxygen pressure is maintained at 760 millimeters. In these tests the system pressure is maintained at 760 millimeters by the addition of nitrogen. The results indicate that certain oil samples may give very large increases in power factor under limited oxygen conditions as compared to what is obtained under the continuous type of test. The power-factor stability of different samples of oils varies over a very wide range under limited oxygen. It is not definitely known at the present time whether such stability is primarily a function of the hydrocarbon constitutents of the oil or whether it is considerably affected by the presence of nonhydrocarbon components or natural inhibitors in the oils. It is believed that there are many applications of electrical insulating oils in which this limited oxidation test would be particularly applicable. This may be true of oil-impregnated paper cables since residual amounts of oxygen may be available to the oil from the oil or the paper.

A Study of the Electric Hygrometer; *R. N. Evans.* In a previous paper on the determination of water in insulating oil, use was made of the electric hygrometer developed by Dunmore at the National Bureau of Standards. Because of the more general application of the device where small amounts of water are vital to industrial operations, a study of such factors as time of approach to equilibrium, temperature, inert gas pressure, mass of hygroscopic salt, mass of water on the unit, and resistance of the unit was carried out. It was shown experimentally that the resistance of the electric hygrometer may be expected to follow the water-vapor pressure in a regular manner except at a water-vapor pressure below that of the saturated solution of the salt used as the electrolyte. By selecting the desired saturated solution, the electric hygrometer or a device of similar principle could be adapted to the control of humidity in industrial operations. Because of hysteresis, there is little possibility that the electric hygrometer can be used for water in oil determinations where one is interested in the mass of water in a closed space and not the vapor pressure of water.

A Manometric Procedure for the Determination of Water in Insulating Oil; *R. N. Evans.* The method consists of two pressure readings in a fixed volume before and after the removed vapors from the oil sample have been exposed to a saturated film of lithium chloride monohydrate. It has been found that equilibrium saturated pressure is attained very rapidly and sorption of organic vapors is reduced to a minimum because of the small quantity of lithium chloride monohydrate employed (approximately one milligram). A compromise between the water capacity of the film and the size of the oil sample is effected by a series of calibrated volumes separated by stopcocks. The method is more precise than other methods known to the author. A complete analysis may be made easily in 30 minutes.

Wax Formation in Stamp Capacitors; *W. N. Arnquist and C. E. Trautman.* In previous reports to this conference, some test results were presented which concerned the electrical stability of paper impregnated with light mineral oils. This report describes the results of further tests of this nature where the principal physical variable was the electrode material. The test units were small parallel plate capacitors, known as stamp capacitors, which previously have been found useful for evaluating the stability of light mineral oil in the presence of electrical stress under oxidizing conditions. In these experiments, copper and lead as well as aluminum were used as electrode materials. As would be expected, copper accelerates the rate of power-factor rise considerably. The regular increase in capacitance (although slight) during the first part of the test is evidence that the copper merely accelerated the normal oxidation deterioration that takes place in these tests. Incidentally, in this respect the effect of copper was found to be greater than that of lead. Of principal interest is the maximum in both power factor and capacitance that resulted when copper was present as an electrode material. When these results were first obtained, the tests were stopped and the capacitors taken apart to determine what had caused the abrupt drop in capacitance. In these capacitors rather large amounts of wax were found. Since the capacitance values decreased appreciably, it is apparent that the average dielectric constant must have decreased correspondingly. This decrease in the average dielectric constant must be interpreted in terms of void formations in the dielectric. The drop in power factor of the capacitors is also explained by the wax and void formation.

Dielectric Nomenclature; *H. H. Race* (*F'39*). Standardization of symbols and nomenclature is desirable wherever possible so that workers in a particular field may be exactly understood by each other and also so that casual readers may find the least possible confusion in attempting to understand papers by different authors on similar subjects. In choosing a quantity through which it is desired to interpret experimental results, there are three considerations of major importance:

(1) The possible physical meaning or interpretation of that quantity in terms of known physical laws.

(2) No ambiguity as to definition or meaning.

(3) Elimination as far as possible of other physical quantities which vary with the experimental parameters being studied.

To meet these requirements we have been using for over ten years in discussion and in published papers a system of nomenclature and definitions for dielectric constant, loss factor, and power factor, the essential feature of which is that the loss factor is a measure of energy dissipated, independent of energy stored. A fuller account of this system may be found in the appendix of the paper "Calorimetric Measurement of Dielectric Losses in Solids" by H. H. Race and S. C. Leonard, *AIEE Transactions*, volume 55, 1936 (December section), pages 1347–56.

The Effect of Corona Deposit on the Flashover Voltage of Suspension Insulator Units; *C. L. Dawes (F'35) and N. Petrou.* At the AIEE winter convention, January 1937, a paper, "The Electrical Characteristics of Suspension Insulator Units" was presented by one of the authors (with R. Reiter), showing that in the presence of humidity the electrical characteristics, such as power loss, power factor, and capacitance, of suspension-insulator units showed a progressive increase, with continuous application of voltage. A microscopic study of the insulator surface showed that an "island" deposit accounted for the change in the electrical characteristics. Since the deposit appeared to be semiconducting it was felt that its gradual increase with time would lower the sparkover voltage of the unit. Until recently it has not been possible to investigate this effect further. Recent preliminary tests showed that the deposit did lower the sparkover voltage materially. When the deposit was removed by cleaning, the sparkover voltage returned to normal. In order to know accurately and be able to control the humidity and temperature a special test chamber, 7.3 by 7 by 7.7 feet was constructed, a moisture-resisting varnish being used on the walls. The tests conducted in this chamber show that the sparkover voltage decreases as time goes on, this effect being due to the gradual accumulation of deposit.

Résumé of Recent Insulation Researches Undertaken by The Research Department of The Detroit Edison Company; *H. S. Walker.* The following are the researches of a fundamental type: Oil deterioration is being investigated by studying the effect of additions of known types of compounds upon the power factor of insulating oils. A unique infrared absorption spectrograph is under construction and is to be used, at least partially, for the determination of certain chemical groups present in deteriorated insulating liquids. Electrochemical potential differences are being measured in semiconducting liquids of low dielectric constant for the determination of certain pertinent ionic data in such systems. A research on the products formed in the bombardment of decalin is now being carried out by means of electron microscopy, dialysis, and spectroscopy for the determination of the size and chemical nature of the particles responsible for high power factor. Among the more important practical researches are the following: A new 120-kv gas-filled cable, now being installed, called for intensive co-operation on the part of the research department of The Detroit Edison Company and involved a wide range of various tests. The maximum allowable overload that a 24-kv cable can carry without undue deterioration for a short emergency period is now being determined. The service-aging research on 24-kv cables, started several years ago, is still under way, and further tangible results are expected in a year's time. Comparative heat-dissipation measurements in gas and oil-filled pipes containing cables are showing interesting results. The pressure-temperature characteristics taken on pure lead-, calcium-lead- and cadmium-magnesium-calcium-lead-sheathed 24-kv cables indicate that no excessive pressures develop in any of these.

Good Illumination Aids War Production

Two-lamp fluorescent units provide an illumination level of 35–40 foot-candles in plant of the Monarch Machine Company, Sydney, Ohio; spacing 10 feet by 10 feet; mounting height 12 to 13 feet

INSTITUTE ACTIVITIES

Tentative Program Announced for 1942 Winter Convention

Notwithstanding the war, a program representing technical developments in many fields, and including the customary social activities, has been arranged for the AIEE winter convention, which will be held in New York, N. Y., January 26–30, 1942, with headquarters in the Engineering Societies' Building. The mornings and afternoons will be taken up with 21 technical sessions, 4 of which are combined with conferences, and in addition 5 other conference sessions will be held. During the evenings the smoker, Edison medal presentation, and dinner-dance will take place as usual. Because of war conditions, no inspection trips to industrial plants or utilities will be arranged, but plans are being made for other interesting trips.

MEDAL PRESENTATIONS

On Wednesday evening, January 28, the Edison medal, highest honor of the AIEE, will be presented in the Engineering Auditorium to Doctor John B. Whitehead (A'00, F'12) director, school of engineering, The Johns Hopkins University. The medal was awarded to Doctor Whitehead "for his contributions to the field of electrical engineering, his pioneering and development in the field of dielectric research, and his achievements in the advancement of engineering education."

The Alfred Noble prize will be presented to Robert F. Hays, Jr. (A'36) at the general session on Wednesday morning. The prize was awarded for his paper entitled "Development of the Glow Switch," [*AIEE Transactions*, volume 60, 1941 (May section), pages 223–5]. Biographical sketches of Doctor Whitehead and Mr. Hays appear in the "Personal" section of this issue.

ENTERTAINMENT

For the smoker, to be held on Tuesday evening, January 27, the Commodore Hotel, popular in previous years, has again been selected. As usual, there will be a supper followed by a show. The seating will be at tables of ten with ample space to move around. Members are urged to send their reservations to the AIEE smoker committee, 33 West 39th Street, New York, N. Y., at an early date. All tables will be reserved. Tickets will be $3.75 per person. Higher costs and Federal tax are reflected in the slight increase in the price of this and other entertainment features over that of former years.

On Thursday evening, January 29, the dinner-dance and buffet supper will be held at the Waldorf-Astoria Hotel. Dinner and dancing will be on the Starlight Roof. Jerry Sears' orchestra will provide music for both dinner and dancing.

Arrangements have been made for a special rate on rooms for those who wish to stay over night or to dress at the Waldorf-Astoria. For room reservations write or telephone the hotel, mentioning the AIEE. The program for the evening is as follows:

7:00 to 9:00 p.m.	Dinner
9:00 to 9:30 p.m.	President's reception
9:30 to 2:00 a.m.	Dancing
Midnight to 2:00 a.m.	Buffet supper

Tickets for the dinner-dance will be $6.00 per person; for the dance and buffet supper $3.75 per person; and for the buffet supper $2.25 per person. The higher cost of the dinner and the Federal tax are reflected in the increase in price over former years. Seating reservations at the dinner will be for 10 persons at a table but, where required, parties of 8 or 12 persons can be accommodated. Reservations should be made with AIEE dinner-dance committee, 33 West 39th Street, New York, N. Y., and checks made payable to "Special Account, AIEE." All such requests should include names of guests and desired seating arrangements. The committee requests that tickets be purchased as early as possible.

Special entertainment for women guests will be arranged by the women's entertainment committee under the chairmanship of Mrs. G. S. Rose. A luncheon and bridge will be held at the Hotel Pierre. For certain events there will be a nominal charge for all women participating in order to defray expenses.

REGISTRATION AND HOTELS

All members who have received an advance registration card should fill in and mail the card promptly. Upon arrival at the convention, if you have registered

Rates for Some of the Available Hotels

Hotel	Location	Rooms With Private Bath: Single	Double
Ambassador	Park Avenue and 51st Street	$6.00– 8.00	$8.00–10.00
Astor	Broadway and 44th Street	3.50– 6.00	6.00– 8.00
Belmont Plaza	Lexington Avenue and 49th Street	3.50– 5.00	5.00– 7.00
Biltmore	Madison Avenue and 43d Street	5.50–12.00	7.50–14.00
Bristol	129 West 48th Street	2.50– 4.00	3.50– 6.00
Commodore	Lexington Avenue and 42d Street	3.50– 5.50	5.50– 8.80
Edison	228–248 West 47th Street	3.00– 4.00	4.50– 7.00
Governor Clinton	31st Street and 7th Avenue	3.30– 5.50	4.40– 7.70
Lexington	Lexington Avenue and 48th Street	4.00– 6.00	5.50– 8.00
Lincoln	Eighth Avenue and 44th Street	3.00– 4.50	4.00– 6.50
McAlpin	Broadway and 34th Street	3.30– 7.70	4.95– 9.90
Murray Hill	Park Avenue and 40th Street	2.50– 4.00	4.00– 6.00
New Yorker	8th Avenue and 34th Street	4.00– 8.00	6.00–10.00
Pennsylvania	7th Avenue and 32d Street	3.85– 6.60	5.50– 8.80
Plaza	Fifth Avenue and 59th Street	6.00– 9.00	8.00–13.00
Roosevelt	Madison Avenue and 45th Street	5.00– 9.00	7.00–12.00
Vanderbilt	Park Avenue and 34th Street	3.00– 5.00	5.00– 8.00
Waldorf-Astoria	Park Avenue and 50th Street	7.00–12.00	10.00–15.00

Summarized Schedule of Principal Events

Monday, January 26

9:00 a.m.	Registration
9:30 a.m.	Power Generation
9:30 a.m.	Light traction
9:30 a.m.	Conference on use of substitute materials in the communication industry
2:00 p.m.	Power generation and transmission
2:00 p.m.	Heavy traction
2:00 p.m.	Conference on national defense lighting

Tuesday, January 27

9:30 a.m.	Switching equipment
9:30 a.m.	Auxiliary traction
9:30 a.m.	Communication
9:30 a.m.	Standards session and conference
2:00 p.m.	System switching
2:00 p.m.	Educational session and conference
2:00 p.m.	Domestic and commercial applications session and conference
8:15 p.m.	Smoker at the Commodore Hotel

Wednesday, January 28

10:00 a.m.	General session
2:00 p.m.	Symposium on distribution systems in war time
2:00 p.m.	Basic sciences Conference on what Institute Sections and members can do to help in the emergency program
8:15 p.m.	Edison medal presentation

Thursday, January 29

9:30 a.m.	Lightning
9:30 a.m.	Symposium on asynchronous machinery
2:00 p.m.	Lightning arresters and protection
2:00 p.m.	Air transportation session and conference
7:00 p.m.	Dinner-dance at the Waldorf-Astoria Hotel

Friday, January 30

9:30 a.m.	Protective relays
9:30 a.m.	Electrical machinery
9:30 a.m.	Conference on arc-back in mercury-arc rectifiers
2:00 p.m.	Instruments and measurements
2:00 p.m.	Industrial power applications
2:00 p.m.	Conference on influence of acceptance and maintenance testing on successful relay design and operation

Tentative Technical Program

Monday, January 27

9:30 a.m. Power Generation

41-158. A Turbine-Governor Performance Analyzer. **W. O. Osbon**, Westinghouse Electric and Manufacturing Company

42-72. Control of Tie-Line Power Swings. **C. Concordia** and **H. S. Shott**, General Electric Company, and **C. N. Weygandt**, University of Pennsylvania

42-73. Supplementary Control of Prime-Mover Speed Governors. **S. B. Crary** and **J. B. McClure**, General Electric Company

9:30 a.m. Light Traction

42-49. A Control System for Modern Multiple Unit Rapid Transit. **H. G. Moore**, General Electric Company

42-50. Modern Electrical Equipment for Industrial Diesel-Electric Locomotives. **Lanier Greer**, General Electric Company

42-52. PCC Car Operating Results in Pittsburgh. **W. J. Clardy**, Westinghouse Electric and Manufacturing Company

9:30 a.m. Conference on Use of Substitute Materials in the Communication Industry

Following a brief introductory statement outlining the general situation which necessitates the use of substitute materials, there will be brief talks by representatives of the various branches of the communication industry telling what has already been done, what is under way, and what remains to be done in connection with the use of substitute materials. There will be ample opportunity for informal general discussion and questions, following the talks.

2:00 p.m. Power Generation and Transmission

Address: "Power for War Needs." **J. A. Krug**, chief of power branch, Office of Production Management

Report of Joint AIEE–American Society of Mechanical Engineers Committee on a Specification for Speed Regulation for Prime Movers Intended to Drive Electric Generators. **M. J. Steinberg**, chairman

Address "Induction Heating Aids Progress of Electric Welding." **C. J. Holslag**, president, Electric Arc Cutting and Welding Company

42-36. Synthetic or Equivalent Load-Curves. **R. F. Hamilton**, consulting engineer

42-53. Facilities for the Supply of Kilowatts and Kilovars. **K. K. Sels** and **Theodore Seely**, Public Service Electric and Gas Company

2:00 p.m. Heavy Traction

42-54. Single-Phase A-C Electric Locomotives on the Pennsylvania Railroad—Protection and Tonnage Rating. **H. C. Griffith**, Pennsylvania Railroad Company

42-23. Progress in Design of Electrical Equipment for Large Diesel-Electric Locomotives. **G. F. Smith**, Westinghouse Electric and Manufacturing Company

42-55. Electropneumatic Brakes for High-Speed Trains, With Particular Reference to Their Electrical Features. **J. C. McCune**, Westinghouse Air Brake Company

2:00 p.m. Conference on National Defense Lighting

A symposium has been arranged on the part that modern lighting will play in civilian and military defense. Emphasis will be placed on the research and test data now available as a result of many investigations undertaken during the past year. The speakers have been actively engaged in these investigations and are well qualified to discuss authoritatively the following subjects:

(*a*). A Civil Defense Program for the United States

(*b*). Lighting for Adequate Civil Defense

1. Black-outs, dim-outs, glare barrages
2. Lighting for civilian activities during black-out

(*c*). Lighting for Night Maneuvers

Discussions on all subjects by those attending the conference are invited.

Tuesday, January 27

9:30 a.m. Switching Equipment

42-12. Field Tests on High-Capacity Station Breakers. **H. D. Braley**, Consolidated Edison Company of New York, Inc.

42-30. Field Tests on High-Capacity Air-Blast Station-Type Circuit Breakers. **H. E. Strang** and **W. F. Skeats**, General Electric Company

42-41. A 2,500,000-Kva Compressed-Air Powerhouse Breaker. **L. R. Ludwig, H. M. Wilcox**, and **B. P. Baker**, Westinghouse Electric and Manufacturing Company

42-38. A Fast Circuit Breaker. **D. I. Bohn**, Aluminum Company of America, and **Otto Jensen**, I-T-E Circuit Breaker Company

42-9. Field Tests and Performance of a High-Speed 138-Kv Air-Blast Circuit Breaker. **Philip Sporn**, American Gas and Electric Service Corporation, and **H. E. Strang**, General Electric Company

42-26. High-Capacity Circuit-Breaker Testing Station. **J. B. MacNeill** and **W. B. Batten**, Westinghouse Electric and Manufacturing Company

9:30 a.m. Auxiliary Traction

42-56. Acoustics and the Quiet Train Ride. **W. A. Jack**, Johns-Manville Research Laboratories

42-51. Progress in Development of Trolley-Coach Overhead Reflected in Higher Service Standards. **L. W. Birch**, Ohio Brass Company

9:30 a.m. Communication

42-6. Frequency-Modulated Carrier-Telegraph System. **F. B. Bramhall** and **J. E. Boughtwood**, Western Union Telegraph Company

42-57. A New Instrument for Recording Transient Phenomena. **S. J. Begun**, The Brush Development Company

42-58. Recent Developments in Burying Telephone Cables. **Donald Fisher** and **T. C. Smith**, American Telephone and Telegraph Company

9:30 a.m. Standards Session and Conference

42-59. "Hot Spot" Winding Temperatures in Self-Cooled Oil-Insulated Transformers. **F. J. Vogel** and **Paul Narbutovskih**, Westinghouse Electric and Manufacturing Company

CP.† Application of Apparatus and Conductors Under Various Ambient Temperature Conditions. **R. E. Hellmund** and **P. H. McAuley**, Westinghouse Electric and Manufacturing Company

No. 1A. Report on General Principles for Rating of Electrical Apparatus for Short Time, Intermittent or Varying Duty, **P.L. Alger**, chairman, AIEE standards co-ordinating committee 4

CP.† The Thermal Co-ordination of Low-Voltage A-C Circuits. **B. W. Jones**, General Electric Company

Reports by co-ordinating committee chairmen

● **PAMPHLET reproductions of authors' manuscripts of the numbered papers listed in the program may be obtained as noted in the following paragraphs.**

● **ABSTRACTS of most papers appear on pages 42–7 of this issue, pages 598–601 of the December 1941 issue, and for paper 41-158 page 447 of the September 1941 issue.**

● **PRICES and instructions for securing advance copies of these papers accompany the abstracts. Mail orders are advisable, particu-**

2:00 p.m. System Switching

42-24. High-Speed Single-Pole Reclosing. **J. J. Trainor**, Public Service Company of Indiana, Inc.; **J. E. Hobson**, Illinois Institute of Technology; and **H. N. Muller, Jr.**, Westinghouse Electric and Manufacturing Company

42-35. Relays and Breakers for High-Speed Single-Pole Tripping and Reclosing. **S. L. Goldsborough** and **A. W. Hill**, Westinghouse Electric and Manufacturing Company

42-31. Analysis of the Application of High-Speed Reclosing Breakers to Transmission Systems. **S. B. Crary, L. F. Kennedy**, and **C. A. Woodrow**, General Electric Company

42-2. Relative Value of Different Types of Overcurrent Protection for Distribution Circuits. **G. F. Lincks**, General Electric Company

42-8. Performance of Ground Relayed Distribution Circuits During Faults to Ground. **C. L. Gilkeson**, Virginia Electric and Power Company, and **P. A. Jeanne** and **J. C. Davenport, Jr.**, Bell Telephone Laboratories, Inc.

2:00 p.m. Education Session and Conference

CP.† A Backward Look for a Forward Plan. **F. C. Hockema**, Purdue University

CP.† Refresher Programs at the Graduate Level in the Post-War Period. **H. W. Bibber**, Ohio State University

42-34. Evening Courses at Graduate Levels—A Challenge to Colleges of Engineering. **Robin Beach**, The Polytechnic Institute of Brooklyn

2:00 p.m. Domestic and Commercial Applications Session and Conference

42-69. Utilization Voltages. **H. P. Seelye**, The Detroit Edison Company

Specially invited speakers will discuss the various aspects of domestic and commercial utilizations of electricity.

Wednesday, January 28

10:00 a.m. General Session

Presentation of Alfred Noble Prize to Robert F. Hays, Jr.

Address by speaker to be announced

2:00 p.m. Symposium on Distribution Systems in War Time

42-60. Electric Power Distribution Systems in War Time. **Philip Sporn**, American Gas and Electric Service Corporation

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larly from out-of-town members as an adequate supply of each paper at the convention cannot be assured. Only numbered papers are available in pamphlet form.

● COUPON books in $5.00 denominations are available for those who may wish this convenient form of remittance.

● THE PAPERS regularly approved by the technical program committee normally will be published in Transactions; many will appear in Electrical Engineering.

42-42. Power Supply to Distribution Substations in War Time. **H. P. St. Clair**, American Gas and Electric Service Corporation

42-61. Distribution Substations and War-Time Necessities. **F. C. Poage** and **M. W. Reid**, Ebasco Services, Inc.

42-62. Underground Distribution Systems in War Time. **L. R. Gaty**, Philadelphia Electric Company

42-45. Overhead Distribution Systems in War Times. **Harold Cole**, The Detroit Edison Company

2:00 p.m. Basic Sciences

42-43. Saturated Synchronous Machines Under Transient Conditions in the Pole Axis. **Reinhold Rüdenberg**, Harvard University

42-27. Formulas for the Magnetic Field Strength Near a Cylindrical Coil. **H. B. Dwight**, Massachusetts Institute of Technology

42-33. The Electric Strength of Nitrogen and "Freon" Under Pressure. **H. H. Skilling**, Stanford University, and **W. C. Brenner**, Westinghouse Electric and Manufacturing Company

Thursday, January 29

9:30 a.m. Lightning

42-22. Impulse and 60-Cycle Characteristics of Driven Grounds—II. **P. L. Bellaschi** and **R. E. Armington**, Westinghouse Electric and Manufacturing Company, and **A. E. Snowden**, Carnegie Institute of Technology

42-14. Shielding of Substations. **C. F. Wagner**, **G. D. McCann**, and **C. M. Lear**, Westinghouse Electric and Manufacturing Company

42-16. Lightning Investigation at High Altitudes in Colorado. **L. M. Robertson**, Public Service Company of Colorado, and **W. W. Lewis** and **C. M. Foust**, General Electric Company

42-18. Lightning Investigation on 132-Kv Transmission System of the American Gas and Electric Company. **I. W. Gross** and **G. D. Lippert**, American Gas and Electric Service Corporation

42-37. The Influence of Towers and Conductor Sag on Transmission Line Shielding. **R. W. Sorensen** and **R. C. McMaster**, California Institute of Technology

42-74. Lightning Investigation on Wallenpaupack–Siegfried 220-Kv Line of Pennsylvania Power and Light Company. **Edgar Bell** and **F. W. Packer**, Pennsylvania Power and Light Company

9:30 a.m. Symposium on Asynchronous Machinery

42-63. Variable Speed Drive for U. S. Army Air Corps Wind Tunnel at Wright Field. **A. M. Dickey**, Army Air Corps, and **C. M. Laffoon** and **L. A. Kilgore**, Westinghouse Electric and Manufacturing Company

42-64. A Study of the Modified Kramer or Asynchronous-Synchronous Cascade Variable Speed Drive. **M. M. Liwschitz**, The Polytechnic Institute of Brooklyn, and **L. A. Kilgore**, Westinghouse Electric and Manufacturing Company

42-65. Large Adjustable Speed Wind Tunnel Drive. **C. C. Clymer**, General Electric Company

42-4. The Doubly Fed Machine. **C. Concordia**, **S. B. Crary**, and **Gabriel Kron**, General Electric Company

42-3. Equivalent Circuits for the Hunting of Electrical Machinery. **Gabriel Kron**, General Electric Company

2:00 p.m. Lightning Arresters and Protection

42-66-ACO.* Back-Up Protection of the Boulder-Dam-City of Los Angeles Transmission Line. **C. P. Garman**, Bureau of Power and Light, City of Los Angeles, and **L. F. Kennedy**, General Electric Company

42-17. Field Investigation of the Characteristics of Lightning Currents Discharged by Arresters. **I. W. Gross**, American Gas and Electric Service Corporation, and **G. D. McCann** and **Edward Beck**, Westinghouse Electric and Manufacturing Company

42-28. Distribution-Type Lightning Arrester Performance Characteristics (report). Lightning Arrester Subcommittee, Committee on Protective Devices

42-10. Temperature and Electric Stress in Impregnated-Paper Insulation. **J. B. Whitehead** and **W. H. MacWilliams, Jr.**, The Johns Hopkins University

2:00 p.m. Air Transportation Session and Conference

A D-C Telemeter or D-C Selsyn for Aircraft. **R. G. Jewell and **H. T. Faus**, General Electric Company

The Magnetic Drag Tachometer. **R. G. Ballard, General Electric Company

Aircraft Voltage Regulator and Cutout. **R. C. Jones, **D. W. Exner**, and **S. H. Wright**, Westinghouse Electric and Manufacturing Company

The Application of Voltage Regulators to Aircraft Generators. **L. W. Thompson and **F. E. Crever**, General Electric Company

Friday, January 30

9:30 a.m. Protective Relays

42-13. Multichannel Carrier-Current Facilities for a Power Line. **P. N. Sandstrom** and **G. E. Foster**

42-20. Loss-of-Field Protection for Generators. **G. C. Crossman**, **H. F. Lindemuth**, and **R. L. Webb**, Consolidated Edison Company of New York, Inc.

42-39. Transient Characteristics of Current Transformers During Faults. **C. Concordia** and **H. S. Shott**, General Electric Company, and **C. N. Weygandt**, University of Pennsylvania

42-11. Current Transformer Performance Based on Admittance Vector Locus. **A. C. Schwager**, Pacific Electric Manufacturing Corporation

†CP: Conference paper; no advance copies are available; not intended for publication in *Transactions*.

*ACO: Advance copies only available; not intended for publication in *Transactions*.

** Advance pamphlet copies not available.

42-40. Linear Couplers for Bus Protection. **E. L. Harder**, **E. H. Klemmer**, **W. K. Sonnemann**, and **E. C. Wentz**, Westinghouse Electric and Manufacturing Company

9:30 a.m. Electrical Machinery

42-1. Progress Report of D-C Testing of Generators in the Field. **E. R. Davis** and **M. F. Leftwich**, Duke Power Company

42-67. Four-Winding Transformers. **T. C. McFarland**, University of California

42-68. Correction for Saturation. **T. C. McFarland**, University of California

42-44. Current Loci for the Capacitor Motor. **T. C. McFarland**, University of California

42-25. Resistance-Welding Transients. **E. E. Kimberly**, Ohio State University

9:30 a.m. Conference on Arc-Back in Mercury-Arc Rectifiers

Sponsored by the joint subcommittee on electronics, this conference will take the form of an informal round-table discussion. There will be no fixed program and the objective will be to encourage as many as possible to take part in order that a profitable interchange of experiences may be obtained.

2:00 p.m. Instruments and Measurements

42-15. Measurement of Maximum Demand. **P. M. Lincoln**, Therm-Electric Meters Company, Inc.

42-5. The Acceleration Oscillogram Method of Motor-Torque Measurement. **C. R. Atkinson** and **E. G. Downie**, General Electric Company

42-70. Design of Long-Scale Indicating Instruments. **A. J. Corson**, **R. M. Rowell**, and **S. C. Hoare**, General Electric Company

42-71. Improvement in Modern Meter-Testing Technique. **E. E. Lynch** and **M. A. Princi**, General Electric Company

2:00 p.m. Industrial Power Applications

42-21. The Fundamentals of Industrial Distribution Systems. **D. L. Beeman** and **R. H. Kaufmann**, General Electric Company

42-49. Electrical Drives for Wide Speed Ranges. **G. A. Caldwell** and **W. H. Formhals**, Westinghouse Electric and Manufacturing Company

42-19. A Static Voltage Regulator Insensitive to Load Power Factor. **C. N. Summers** and **T. T. Short**, General Electric Company

42-32. A New Voltage-Regulating Relay Plus Line-Drop Compensator. **H. J. Carlin**, Westinghouse Electric and Manufacturing Company

2:00 p.m. Conference on Influence of Acceptance and Maintenance Testing on Successful Relay Design and Operation

This conference will be devoted particularly to the value of testing in bringing out the need for improvement in various types and forms of relays. The primary objective of acceptance and maintenance testing is the prevention or elimination of incorrect relay operation and the conference will deal with difficulties experienced with protective relays and the remedies which have been found successful. The limitations in application as found by relay test characteristics will also be discussed. Three discussion leaders will present their views, after which the conference will be opened for general discussion. The chairman is **L. F. Kennedy**, and the discussion leaders will be **M. W. Evans**, Duquesne Light Company; **J. P. Kisch**, Public Service Electric and Gas Company; and **A. W. Rauth**, Consumers Power Company.

by mail, do not fill in another card—just ask for your badge.

Hotel reservations should be made by writing directly to the hotel preferred. For convenience the rates of a few of the near-by hotels are given in the table on page 35.

COMMITTEES

The members of the 1942 winter convention committee are as follows:

D. A. Quarles, *chairman;* J. W. Barker, T. F. Barton, G. E. Dean, E. E. Dorting, J. F. Fairman, L. C. Miller, D. H. Moore, J. H. Pilkington, C. S. Purnell, W. W. Truran.

Chairmen of the subcommittees are:

S. B. Graham, *dinner-dance;* J. E. McCormack, *smoker;* R. F. Brower, *inspection trips;* and Mrs. G. S. Rose, *women's entertainment.*

AIEE Nominating Committee for 1942–43 Named

In accordance with the Institute's bylaws, the national nominating committee of the AIEE will meet during the winter convention to be held in New York, N. Y., January 26–30, 1942, for the purpose of nominating national officers to be voted upon by the membership in the spring of 1942. Members of this year's national nominating committee are as follows:

Representing the Board of Directors

T. F. Barton, General Electric Company, New York, N. Y.

Mark Eldredge, 3000 39th Street, N. W., Washington, D. C.

F. Malcolm Farmer, Electrical Testing Laboratories, New York, N. Y.

T. G. Le Clair, Commonwealth Edison Company, Chicago, Ill.

L. R. Mapes, Illinois Bell Telephone Company, Chicago, Ill.

Alternates:

Everett S. Lee, General Electric Company, Schenectady, N. Y.

K. L. Hansen, 2916 North Prospect Avenue, Milwaukee, Wis.

Representing the Ten Geographical Districts

1. A. G. Conrad, Yale Station DLE, New Haven, Conn.

2. Harry W. Asgood, Potomac Electric Power Company, Washington, D. C.

3. Donald A. Quarles, Bell Telephone Laboratories, Inc., New York, N. Y.

4. J. G. Tarboux, Ferris Hall, University of Tennessee, Knoxville, Tenn.

5. T. N. Lacy, Michigan Bell Telephone Company, Detroit, Mich.

6. B. E. S. Ellsworth, 521 West Third Street, North Platte, Nebr.

7. R. W. Warner, Department of Electrical Engineering, University of Texas, Austin, Tex.

8. J. M. Gaylord, Metropolitan Water District of Southern California, Los Angeles, Calif.

9. Joseph Hellenthal, Puget Sound Power and Light Company, Seattle, Wash.

10. C. A. Price, Canadian Westinghouse Company, Ltd., Hamilton, Ont.

Alternates:

4. Stanley Warth, Southern Bell Telephone and Telegraph Company, Jacksonville, Fla.

6. D. J. DeBoer, Loup River Public Power District, Columbus, Nebr.

10. A. H. Frampton, Hydro-Electric Power Commission, Toronto, Ont., Canada

Provisions of the AIEE constitution and bylaws relating to nominations were given in *Electrical Engineering* for November 1941, pages 552–3.

In addition to those to be designated by the national nominating committee, nominations also may be made independently, by petition of 25 or more members sent to the national secretary at Institute headquarters, not later than March 25, to be placed before the nominating committee for inclusion in the ballot of such candidates as are eligible. Petitions for the nomination of vice-president may be signed only by members within the District concerned.

Future AIEE Meetings

Winter Convention

New York, N. Y., January 26–30, 1942

North Eastern District Meeting

Schenectady, N. Y., April 29–May 1, 1942

Summer Convention

Chicago, Ill., June 22–26, 1942

Pacific Coast Convention

Vancouver, B. C., September 9–11, 1942

International Relationships Discussed at Southern District Meeting

Three special features of the Southern District meeting recently held in New Orleans, La., December 3–5, 1941, introduced a distinctly international flavor which, in the light of intervening world events, proved most timely. One of these represented a North-American view of inter-American relationships, another represented a South-American view on the same subject, and the third had to do with China and her current problems of common interest with the other democracies of the world. These speakers were, respectively, Charles A. McQueen of the Office of the Co-ordinator of Inter-American Affairs of the United States State Department: Doctor Gustavo Guerrero, Bolivian consul at New Orleans; Doctor G. H. Wang, Chinese consul at New Orleans.

Mr. McQueen's address on "The Potential of Inter-American Economics" was the principal feature of the opening general session. The essential substance of this address is presented as one of the leading articles in this issue of *Electrical Engineering.*

LATIN AMERICA

A glimpse into Latin America was given to a luncheon gathering Wednesday noon by Doctor Gustavo Guerrero, consul of Bolivia at New Orleans. Describing Latin America as an area twice the size of all of Europe, Doctor Guerrero stated that it has abundant quantities of all the materials of modern life except for a few items that can be found in the United States—a land of vast resources largely untouched as yet. In a position of easy access to all nations of the world, Latin America was described as living on its $4,000,000,000 yearly foreign trade—a trade which by tradition and association has been largely carried on with Europe. Doctor Guerrero intimated that with this traditional market interrupted, and with the growing sentiment against totalitarian conquest, the basic community of interest among the nations of the Americas should become self-evident.

Although "Latin America" is a term convenient to the casual observer in the United States, Doctor Guerrero emphasized the necessity of carefully considering the several distinct peoples of that area in connection with any efforts at technical, social, or political co-operation. He pointed out that as the area was colonized principally from Europe, the strong ties and carryover of customs and business relations must be regarded as only natural rather than as reflecting any local antagonism from the general populace. Although basically Spanish in origin, the present citizens of the Latin American nations reflect varying degrees of assimilation and influence of many different European nations. Notable among these several groups is the German contingent which was described as being widely distributed in strong and influential colonies actively blending their influence with others.

As development goes on, the original tendency to continue the habits and customs of various mother countries is giving way to an evolving local culture of distinct identity in each of 20 nations. Doctor Guerrero repeatedly reminded his North-American audience of the necessity for remembering these old, strong, and natural loyalties and for recognizing the strong individuality of the present national groups, if understanding and effective co-operation among the Americas is to be achieved.

To help his audience to visualize the vastness of Latin America and its resources, Doctor Guerrero recounted briefly a few high lights: that Brazil has 25,000,000 potential horsepower in its rivers, with about 1,000,000 developed, Bolivia 80,000,000 with 10,000 developed; that the original home of rubber, corn, and "Irish" potatoes is in South America; that Brazil has potential cotton-growing acreage adequate to supply the world's present demands, and iron-ore deposits as big as those of the United States; that the area's largely untapped mineral resources include bauxite, manganese, copper, tin, zinc, and other currently "strategic" materials.

Latin America was described as a land of infinite contrast—great cities and great

jungles, permanently snow-capped mountain ranges and thousand upon thousand of miles of shore line, highly developed culture and primitiveness, modern factory and old-world shepherd. He called it a vast land concerning which big mistakes have been made, but where great work is to be done—work rich in rewards for capable modern pioneers of courage and understanding.

CHINA

A few pertinent glimpses into China and into Chinese philosophy were given by Doctor G. H. Wang, Chinese consul at New Orleans as guest speaker at the dinner dance of the New Orleans District meeting. Mr. Wang spoke quite informally and with considerable apparent success in giving his audience a better understanding of two important aspects of China's position in the disturbed world of today—the vastness of her physical domain, and her ability not only to withstand rigorous hardship, but to develop culture and national unity in spite of them. This latter trait was mentioned as having been developed and demonstrated through centuries of necessity. By reminding his audience of China's historic ability literally to absorb mercenary invaders and ultimately to turn them literally into parts of a greater Chinese Empire—as witnessed the early invading hoards of Mongolians, Manchus, and others, Doctor Wang by implication suggested something of the ultimate possible fate of Japan in her continuing war of agression against China.

Doctor Wang emphasized the ultimate value of a basic Chinese philosophy of "space for time" when under attack, a policy and procedure which has enabled China to compensate in geographical space for its relative deficiency in the machinery and equipment required for modern warfare. With specific reference to the prevalent Japanese invasion, Doctor Wang illustrated the application of this philosophy by pointing out that in 1937–38 the Japanese aggressors had penetrated into China perhaps some 800 miles from the seacoast, whereas in the next year the additional penetration was only about ten per cent as great and in 1940 was practically nil; and in 1941 Chinese forces have regained some territory at a time when it was apparent that Japan would have preferred to talk about a Japanese-dictated peace. Doctor Wang closed with a note emphasizing the growing community of economic and other interest between China and the other remaining democracies of the world. These latter thoughts have assumed particular significance in the events which have occurred since the New Orleans meeting.

New Orleans Is Host to Fourth Meeting of Southern District

On December 8, 1933, the New Orleans Section was formed, 62nd of the Institute's active Sections. December 3–5, 1941, the New Orleans Section, now 30th in size among 72 active Sections, was host to the 384 persons who attended the fourth Southern District meeting, held at the St. Charles Hotel. The annual Southern District conference of Student Branches was held concurrently, with activities divided between the St. Charles Hotel and Tulane University. The Tulane Branch was host to 144 students and faculty members from the 17 engineering schools of the District that have Student Branches. An analysis of attendance is given in an accompanying tabulation.

GENERAL SESSION AND LUNCHEON

James M. Todd, first chairman and charter member of the New Orleans Section, presided at the opening general session Wednesday morning. AIEE Vice-President J. E. Housley of the Southern District formally welcomed the 225 persons present for the opening, and National Secretary Henline complimented the Section upon its eight-year growth. President Prince had been scheduled to give his illustrated lecture concerning "Post-War Problems of Industry," but his air trip from Mexico City did not materialize as scheduled. He arrived just in time to speak before the closing session Friday morning. Charles A. McQueen of the Office of the Co-ordinator of International Affairs gave an illuminating insight into some of the aspects of inter-American relationships; his address appears elsewhere in this issue.

Additional inter-American atmosphere was given to the general luncheon Wednesday noon by Doctor Gustavo Guerrero, Bolivian Consul, a special guest for the luncheon, who took his audience on a vivid "word-picture trip" through the enormous area of "Latin America", as reported elsewhere in this issue.

TECHNICAL PROGRAM

Excepting the withdrawal of the scheduled paper on "Application of Electric Welding to Ship Construction," the technical program was carried out essentially as published in the November issue. Attendance at the two technical sessions averaged about 100. Chairman B. P. Babin of the New Orleans Section presided at both sessions, which were held in the morning to facilitate inspection trips and visits to points of local technical, cultural, and historic interest during the afternoons.

A semitechnical lecture given Wednesday evening by Doctor G. D. McCann of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., on the subject "Lightning Phenomena and Its Behavior on Transmission Lines," drew an audience of about 140 persons in competition with the Vieux Carre. The lecture featured Kodachrome projections and the highly graphic mechanical wave-generator developed by Doctor McCann and his associates. Doctor McCann repeated his lecture Friday morning for the special benefit of the student group, for which there was a conflicting program Wednesday evening.

STUDENT PROGRAM

The student program, in addition to participation in the various sessions of the District meeting, provided two formal sessions devoted to student papers. The first of these was held at the St. Charles Hotel Wednesday afternoon, featured six technical papers, and drew an attendance in excess of 150 persons. The second session was held in Gribson Hall on the Tulane University campus about six miles from the hotel, accommodated two nontechnical papers, and drew an attendance of about 90 persons.

Following is an outline of the Student technical program:

Wednesday, December 3. Address of welcome by Professor C. W. Ricker, head of school of electrical engineering, Tulane University; Professor C. B. Norris, chairman of student activities committee, introducing.

Technical papers, Professor William J. Miller presiding:

1. A Power-Angle Indicator for Synchronous Machines, **Edward D. Morton, Jr.,** and **James E. Callahan,** University of Louisville.
2. A Potentiometer RPM Counter, **James B. Tharpe,** Georgia School of Technology.
3. Thyratron-Reactor Lighting Control, **Ellis Levin** and **Stanley G. Dinkel,** Tulane University.
4. Electric-Machine Power Theorem, **George B. Higgins** and **Morton L. Long, Jr.,** University of Louisville.
5. Electronic Control of Wind-Tunnel Force Measurements, **Blaney T. Hines, Jr.,** University of Florida.
6. What Impedance? **Charles L. Ellis** and **Lawrence H. Luallen,** University of Tennessee.

Thursday, December 4. Address of welcome by Dean Paul Brosman of the College

Southern District Meeting Attendance 1928–41

Date	Location	Attendance
1941—Dec. 3–5	New Orleans, La.	384
1938—Nov. 28–30	Miami, Fla.	282
1930—Nov. 19–22	Louisville, Ky.	300
1928—Oct. 29–31	Atlanta, Ga.	400

Analysis of Registration at New Orleans

Classification	New Orleans Section	District 4*	Other Districts	Totals
Members	52	58	18	128
Enrolled Students	45	101		146
Men Guests	33	15	5	53
Women Guests	16	33	8	57
Totals	146	207	31	384

*Outside New Orleans.

of Law, acting president of the University; Professor C. B. Norris, chairman of student activities committee, introducing.

Nontechnical papers, Professor W. W. Hill presiding:

1. Post-War Planning, **George A. Holt,** University of Tennessee.

2. A Suggested System of English Instruction in Engineering Colleges, **Ed Lear,** University of Alabama.

Preparation and presentation of these papers was on a competitive basis. The advance reviewers of the several papers graded them on the basis of content and organization. A group of judges at the sessions drew up a second grading on the basis of effectiveness of presentation. A consolidation of these two sets of grades gave first prize to Morton and Callahan, and second prize to Levin and Dinkle, in the technical-paper group. In the nontechnical group, which was separately judged, first prize went to Lear and second prize to Holt. The prizes were presented at the dinner-dance by AIEE Director F. R. Maxwell, Lieutenant Commander USNR.

ENTERTAINMENT AND TRIPS

A generous program of trips and entertainment features was provided for both men and women. Activities for women guests started with a luncheon Wednesday noon given in the Vieux Carre, the famous old French Quarter, by the Women's Auxiliary of the Louisiana Engineering Society, and included trips and visits to many points of interest. Inspection trips of technical interest included a tour around the New Orleans Harbor on the Dock Board's yacht Hugh McCloskey, inspecting the sewerage and water-supply plants, and the drainage pumping plants that keep the city habitable. Men and women spent an afternoon visiting the D. Godchaux sugar plantation and refinery at Reserve, La., where sugar in practically all stages of processing from growing cane to refined and packaged product was seen. High spot of social affairs was the dinner-dance and entertainment program given Thursday evening in the ballroom at the St. Charles Hotel.

A timely international flavor was given to the dinner-dance by Chinese Consul G. H. Wang and Mrs. Wang, present as special guests of the evening. Doctor Wang spoke informally concerning the political and economic situation in the Orient. His remarks are reported elsewhere in this issue. This meeting was presided over by P. E. Lehde, member of the New Orleans Section and president of the Louisiana Engineering Society.

DISTRICT EXECUTIVE COMMITTEE

The Southern District executive committee held its regular annual business session at the St. Charles Hotel in New Orleans, Tuesday afternoon, December 4, following a luncheon given for it by the New Orleans Section. J. Elmer Housley, AIEE vice-president from the Southern District, presided. All of the 11 Sections in the District were represented; National Secretary H. H. Henline was present on behalf of national headquarters. In addition to a general discussion of problems of interest to the various Sections, the executive committee took the following actions:

1. Selected Professor J. G. Tarboux of the Tennessee Section as the District's representative to the national nominating committee for its winter convention meeting; Stanley Warth of the Florida Section to serve as alternate.

2. Accepted the invitation of the Virginia Section to hold a Southern District meeting in Virginia in 1943, the details of time and place to be decided upon later.

3. Scheduled a meeting of the executive committee to be held in Memphis, Tenn., in the fall of 1942, exact date to be announced later.

BRANCH CONFERENCE

A Student Branch conference called for the purpose of discussing problems of common interest to the various Branches in the District was attended by practically the entire personnel of the various student delegations, as well as by the Student Branch officers and counselors. All 17 of the Branches in the District were represented. Professor C. B. Norris, faculty counselor for the Tulane Branch and chairman of the committee responsible for the student activities of the District meeting, presided. One of the points discussed at some length had to do with the matter of District policy as to nontechnical student papers for the annual student conferences. The trend of discussion revealed strong support for the idea of continuing to encourage papers on other than purely technical topics, especially by underclassmen. This discussion similarly indicated, however, a general preference for an intermixture of technical and nontechnical papers rather than for their segregation in separate sessions such as was done at New Orleans. Discussion of the old question of the relative advantages and disadvantages of having a District student conference in the fall in conjunction with the District meeting, or in the spring after the student's work for the year has been much further advanced, brought out differences of opinion. Upon invitation, National Secretary Henline explained that the decision in such matters rested entirely in the hands of those locally responsible for District activities, and suggested that decisions be based upon local circumstances and preferences. The group voted to hold the 1943 student conference of the Southern District some time in April at the University of Kentucky, Lexington, in response to an urgent invitation from the representatives of that Branch.

Postwar Problems Again Considered at New Orleans Meeting

The series of conferences concerning engineering attention to post-war problems, a series begun at the summer convention last June in Toronto and continued through the Pacific Coast convention, the recent South West District meeting at St. Louis, and several intervening Section meetings including one in Mexico City, was continued by President D. C. Prince at the December 3–5 Southern District meeting in New Orleans. As previously reported, President Prince is preaching widely the philosophy that the costly economic mistakes made in the aftermath of the first World War through lack of foresight should not be repeated in the inevitable aftermath of the present world conflict. It is President Prince's logical thesis that intelligent analysis of the industrial and commercial field and its closely related economic and sociological aspects, coupled with thoughtful and thorough planning, can provide a nation-wide basis of post-war industrial procedures that will reduce greatly the severity of the transition from war-time to peace-time operations. It is President Prince's further thesis, urgently recommended for serious consideration, that efforts in this direction definitely should be made by individuals and groups of individuals in communities large and small throughout the nation rather than left in the hands of any nationally centralized agencies. President Prince points out quite logically that the great national economic disturbances are in essence the cumulative manifestation of a very large number of small and local disturbances; that if the local situations were adequately taken care of by local people under local conditions, no national situation would develop. He points out equally logically that the failure of individuals or local groups to take care of local situations leaves as the only and inevitable alternative a nationally centralized governmental control of industry and commerce to the lasting detriment of the traditional individual initiative that has built America.

The fact that since the New Orleans meeting the United States' position has been changed from that of defense preparation to defense fighting heightens rather than diminishes the ultimate vital importance of long-range industrial and economic planning.

COMMENTS FROM ENGLAND

That such vital problems should be receiving thoughtful consideration in other great democracies in spite of current war-time pressure is at once encouraging and significant. The extent to which people in Great Britain are concerning themselves about post-war problems is indicated in a message to his membership by President J. R. Beard of the Institution of Electrical Engineers of Great Britain, published in the *Journal* of that organization for September 1941. At the suggestion of AIEE Vice-President Everett S. Lee and some of his active associates in AIEE affairs, the entire text of Mr. Beard's brief but pertinent message is published in the following paragraphs:

"In the earlier stages of the war the problem of post-war planning seemed of

distant interest and was discouraged even in the highest quarters as an undesirable diversion of effort from the need to put every ounce of energy into winning the war. In recent months the situation has been much changed and the Government has appointed one leading Minister, Mr. Greenwood, to devote himself entirely to the general problem of planning and another, Lord Reith, to give special attention to its more physical aspects. There was a most interesting debate on post-war planning in the House of Lords on the 26th of February last in which was announced the definite decision of the Government to establish a central planning organization. There was also a somewhat similar debate in the House of Commons on the 19th March, and a further debate in the House of Lords on the 18th July. All these debates are well worth reading in full. Not only has the Government itself taken some definite, even though tentative, steps but much general explanatory work is being done by various organizations, while the professional Institutions of architects and engineers are giving attention to the practical application of planning to specific problems with the full encouragement of the Government.

"This growth of general interest in post-war planning is due partly to recognition of the need to define more clearly to ourselves, our friends, and even our enemies the kind of world for which we are fighting, and partly to realization that post-war problems will be both vast and urgent and will only be successfully overcome if visualized now and planned for in advance in sufficient detail to permit of constructive action immediately on the conclusion of the war. It is also encouraged by a feeling that thoughts of post-war planning are envigorating and helpful to the war effort, in much the same way as recreation is a necessary complement to hard work in times of peace. In these strenuous days ordinary recreation is unattractive and difficult, and we must look on post-war planning as our substitute; an idea which may be commended to those who are somewhat critical of the expenditure of effort on post-war planning.

"It is generally recognized that engineers will have an important part to play in post-war planning, and our own Institution has been giving serious consideration to the problem for the past six months. It has set up a representative post-war planning committee which has appointed various subcommittees to deal with such specialized problems on education, training, research, electricity supply, installations, telecommunications, production, and standardization. An encouraging feature is the tendency to closer association between the senior Institutions representing the three main branches of engineering, as it is apparent that one of the essentials of planning in the engineering world will be so to plan that engineers can speak with one voice and thereby exercise greater influence on both the Government and public opinion.

"The post-war planning committee attach much importance to drawing as widely as possible on the ideas and experience of all the members of the Institution and is therefore encouraging the discussion of the problems in the Local Centres. With this in view the committee are also arranging for certain of their subcommittees to foster the preparation of general papers—the first of which will appear in the *Journal* very shortly—dealing with specific subjects so that these can be widely discussed. Much help is also expected from the newly established Installations Section whose field of activity will be so intimately related to many of the more urgent post-war problems which will arise in the electrical industry. It is hoped that the coming session may see fruitful progress in these aspects of this work which the Institution is particularly qualified to undertake, and that we shall endeavour to base it on sound fundamental principles with a proper balance of broad vision and practical application."

Committee Formed for Middle Eastern District Meeting

The general committee for the Middle Eastern District meeting and Student Branch convention, to be held in Pittsburgh, Pa., October 14–16, 1941, has been announced. The committee is already working to make the meeting successful in spite of the difficulties which will affect it this year. Members of the general committee are:

G. R. Patterson, *chairman;* John B. Rice, *secretary;* C. T. Sinclair, R. L. Dunlap.

Subcommittee chairmen are:

C. A. Powel, *meetings and papers;* E. W. Oesterreich, *finance;* J. A. Cadwallader, *hotels and registration;* H. A. P. Langstaff, *inspection and transportation;* R. C. Gorham, *student activities;* F. R. Dallye, *publicity;* A. E. LaPoe, *entertainment;* Mrs. W. R. Work, *women's entertainment.*

SECTION • • • • •

Meetings on Civic Affairs Urged

Sent by the chairman of the AIEE Sections committee to all Institute vice-presidents. District secretaries, and chairmen of Sections, the following letter is here presented because it is believed by the Sections committee and the technical program committee to be of interest to the membership at large. (See also the letter from Chairman Coover in the December 1941 issue, pages 597–8.)

To All Vice-Presidents, District Secretaries, and Section Chairmen:

It is the opinion of the technical program committee that both National and Section meeting programs occasionally should reflect the interest of the Institute in civic affairs. To this end the technical program committee has planned to have at each national convention one or more sessions on civic affairs or nontechnical subjects. These programs will be arranged to permit free and informal discussion of the program topics.

The AIEE is now the largest engineering society in the United States and should be a leader in broadening the civic activities of engineers. The officers of local Sections have an obligation to help society make intelligent and constructive use of technical developments.

It is felt that such programs, particularly

Electric-power leaders considered their industry's role in the war effort at a meeting of the AIEE New York Section held under auspices of the Section's power group, New York, N. Y., December 10, 1941. Left to right are: Section Chairman D. A. Quarles (M'29), Bell Telephone Laboratories; Ralph Kelly, vice-president, Westinghouse Electric and Manufacturing Company; John C. Parker (F'12), vice-president, Consolidated Edison Company of New York, Inc.; Power Group Chairman J. L. Holton (M'37), New York and Queens Electric Light and Power Company. Text of addresses by Messrs. Kelly and Parker appears elsewhere in this issue.

when participated in by prominent members of society outside of the Institute, will help to secure desirable publicity for the engineer and will tend to develop stronger leadership by the engineer in civic affairs, a condition which is deplorably lacking now in many cases.

It is hoped that all Section officers will arrange to devote at least one meeting each year to a program of this nature. There are many appropriate subjects in this field, such as engineering planning, defense activities, city or regional planning, and the like. Best results are accomplished from a meeting of this nature when several speakers form a panel and the meeting is thrown open for general discussion after the speakers have finished their presentations.

The Sections committee and the technical program committee both will be glad to assist in the selection of topics and in suggesting details for conduct of the meeting. If, in arranging these civic affairs or nontechnical programs any problems arise, the solutions of which would be of interest to the officers of other Sections, please send me a brief story about them so that I may pass the information on to the others who are interested.

M. S. COOVER
Chairman, Sections Committee

ABSTRACTS • • •

TECHNICAL PAPERS previewed in this section will be presented at the AIEE winter convention, New York, N. Y., January 26–30, 1942, and are expected to be ready for distribution in advance pamphlet form within the current month. Copies may be obtained by mail from the AIEE order department, 33 West 39th Street, New York, N. Y., at prices indicated with the abstracts; or at five cents less per copy if purchased at AIEE headquarters or at the convention registration desks.

Mail orders will be filled AS PAMPHLETS BECOME AVAILABLE

Basic Sciences

42-33—The Electric Strength of Nitrogen and "Freon" Under Pressure; *H. H. Skilling (M'34) and W. C. Brenner (A'41). 20 cents.* Results are given of an investigation of the electric strength of nitrogen, of dichlorodifluoromethane (Freon F-12), and of mixtures of these gases. Sparking voltages are presented as measured between spherical electrodes of brass and aluminum and between pointed electrodes of brass, at various spacings, and in gas at pressures ranging from one to several atmospheres. All measurements are for 60-cycle applied voltage. Dichlorodifluoromethane is found to withstand much higher voltages than either air or nitrogen; this advantage is more marked between points than between spheres, which suggests its use in certain types of insulation applications. A small percentage of dichlorodifluoromethane gas in nitrogen produces an anomalously large rise in the electric strength of the gas, indicating practical advantages of such mixtures.

42-43—Saturated Synchronous Machines Under Transient Conditions in the Pole Axis; *Reinhold Rüdenberg (M'38). 25 cents.* The performance of synchronous machines in the transient state is substantially determined by magnetic saturation in the iron circuits, particularly of the main flux in the rotor poles. By suitable combination of the voltage-current equations for the electric and magnetic circuits, a rigorous relation is developed for the change with time of the electromotive force and this can be represented by a graphical construction containing merely the magnetic characteristic of the machine and the electric characteristic of the entire stator circuit. All slow transient currents and voltages can be derived graphically from this diagram. The combined effect of damper circuits and rotor leakage causes a superposed rapid transient variation, the effects of which on short-circuit current and on recovery voltage are derived numerically for saturated conditions of the fluxes. The method of solution can be applied to nearly every kind of transient condition in the pole axis of saturated machines.

Communication

42-6—Frequency-Modulated Carrier Telegraph System; *F. B. Bramhall (M'39) and J. E. Boughtwood (A'41). 15 cents.* The fundamental building block of all carrier-current telegraph systems, whatever their uppermost frequency and communication channel capacity, has been until now a group of voice-frequency channels operated on the well-known amplitude-modulation principle. This paper reviews the general problem of voice-frequency carrier operation; points out the limitations of amplitude modulation and the factors leading to the adaptation of frequency modulation. The theory and principles of frequency modulation as applied to high-speed telegraph signaling are discussed and the factors affecting the design of equipment for the generation and detection of frequency-modulated carriers in the speech-frequency range are outlined. The results of quantitative measurements made under laboratory conditions and on long operating circuits are disclosed. These results indicate that the expected improvement in performance over that obtained with amplitude modulation is achieved. The reduction in fortuitous distortion resulting from extraneous interference and the greater freedom from attenuation changes in the transmission medium are seen to justify the slightly increased circuit complications.

42-57—A New Instrument for Recording Transient Phenomena; *S. J. Begun. 15 cents.* In many cases it is of great importance to study phenomena which do not occur periodically. Such phenomena, called transients, arise, for example, at the time a short circuit appears in a power line, during the discharge of the capacitor of a spot-welding machine, during the starting of electric machinery, and on very many other occasions. Most of the instruments available thus far for investigation of transients employ the method of film recording, which has the disadvantage of requiring a developing process. A new transient recorder has been developed, employing magnetic-tape recording as a means of preserving the record of a transient, and steadily repeating this record on the screen of an oscilloscope. This method has the advantage that it requires no processing and that the same magnetic carrier can be used continuously without loss of material.

42-58—Recent Developments in Burying Telephone Cables; *Donald Fisher (A'35) and T. C. Smith. 15 cents.* In recent years there have been extensive developments in the art of burying cross-country telephone cables. The prevailing method is to feed them into the ground through a moving blade or share carried in a plow which is specially designed for this service. The cable plow is operated as a member of a train consisting of four Diesel caterpillar tractors, a rooter plow which precedes the cable plow, and two caterpillar-type cable-reel trailers which follow it. All this equipment, in a connected train weighing more than 100 tons, travels across country at the rate of a brisk walk, burying the cable as it goes. Special provision is made in the design and use of the plow train to guard against injury to the cable during the placing operation. Adjustments that can be made quickly even while the train is in motion permit burying the cable at any required depth down to 50 inches under the surface. Special apparatus and methods are used for negotiating swamp land, rivers, and mountains.

Domestic and Commercial Applications

42-69—Utilization Voltages; *H. P. Seelye (M'28). 15 cents.* Although utilization voltage is usually considered in terms of the voltage rating of the lamps used it would be preferable if it were conceived as a band of voltages between defined limits. On any ordinary distribution system, the voltage at customers' outlets will normally be distributed through a spread ranging from about 7 to 15 volts. In addition, the variation between systems requires a total spread of some 20 volts for "satisfactory operation" of equipment. A standard has been proposed of 107 to 127 volts, with a preferred spread of 110 to 125 volts. The establishment of a generally accepted standard utilization-voltage spread for the industry, and better understanding of the characteristics of the voltages within that spread, will tend to foster simplification and efficiency in the design, rating, and use of utilization equipment.

Education

42-34—Evening Courses at Graduate Levels—a Challenge to Colleges of Engineering; *Robin Beach (F'35). 15 cents.* Recent "all-out" efforts for national de-

fense have focused attention upon our dearth of highly trained engineering personnel. If superior forces of engineering and overwhelming mass production of death-dealing machines are the ultimate means to victory for the democracies, the importance of training a versatile and highly skilled personnel appears paramount. The instruction through evening courses of engineers already in industry at graduate levels seems to be one of the most promising means of quickly satisfying this urgent demand. Colleges should, where feasible, organize to aid industry by "up-grading" its engineering personnel through specialized graduate courses either by "on campus" or by nonresident instruction. The utilization of others' experiences at this critical period may conserve both time and expense. So the author has undertaken to state his experiences and observations from a long period of years in the organization and supervision of evening courses at graduate levels. He has covered in his article the problems of the administrator, the requisite qualifications of the instructor, the formulation of a curriculum at the master's level and at the doctor's level, the objectives of the thesis, and the problems of organization for nonresident instruction.

Electrical Machinery

42-44—Current Loci for the Capacitor Motor; *T. C. McFarland (M'32). 15 cents.* The questions for stator- and rotor-winding currents are formulated, based on the cross-field theory. Coefficients of the equations are expressed as functions of turn-ratio, speed, and auxiliary-winding capacitive reactance. For a machine of known constants, the currents are evaluated for several speeds and several reactances. A plot of the currents establishes circular loci for conditions of constant speed and of constant reactance. Rules of procedure are suggested for determining the loci for various conditions of speed and capacitive reactance.

42-59—"Hot Spot" Winding Temperatures in Self-Cooled Oil-Insulated Transformers; *F. J. Vogel (M'41) and Paul Narbutovskih (A'32). 15 cents.* The ability to calculate temperatures reached by transformer windings on overloads of limited duration is of importance to operators, as well as designers, in order to utilize available equipment to the best advantage under emergency conditions. The phenomena involved in transformer heating particularly, so far as changes of oil flow are concerned, are such that the problem does not lend itself readily to an exact analysis. The authors describe some experimental data and observations on core-type transformers, pertaining particularly to the relation between the average and the "hot spot" copper temperature, and the effect of temperature on the flow of the cooling medium, which indicate a new method of computing the winding temperature from measurements made at rated load. As shown by comparison with experimental data, the method is conservative, but indicates that higher emergency overloads can be supplied by transformers than previously recommended, without exceeding safe temperature limits.

42-63—Variable-Speed Drive for United States Army Air Corps Wind-Tunnel at Wright Field; *A. M. Dickey, L. A. Kilgore (M'37) and C. M. Laffoon (M'39). 15 cents.* A 40,000 horsepower variable speed drive has been built for the large wind tunnel at Wright Field. This drive consisted of a single wound-rotor induction motor, with the secondary power returned to the line through a variable speed and a constant speed a-c–d-c motor-generator set with synchronous a-c machines. The paper gives a description of the apparatus and methods of operation and a discussion of certain special problems such as the steady-state and dynamic stability of this type of drive.

42-64—A Study of the Modified Kramer or Asynchronous-Synchronous Cascade Variable-Speed Drive; *M. M. Liwschitz (M'39) and L. A. Kilgore (M'37). 25 cents.* Several large wind-tunnel drives recently built have involved a system of speed control which seldom has been used commercially and a number of new problems had to be solved. The system consists of a wound-rotor induction motor whose slip rings are connected to a synchronous motor driving a variable speed d-c generator which feeds a constant speed d-c–a-c set putting the major part of the secondary power back into the line. This drive is found to be very efficient and particularly suited to very large fan or pump drives where a wide range of speed is required. The problems of steady state and dynamic stability are discussed and some novel methods of analysis given.

42-65—Large Adjustable-Speed Wind-Tunnel Drive; *C. C. Clymer (Application Pending). 15 cents by mail.* The importance of research in the field of aerodynamics calls for larger and more accurately controlled wind tunnels. This requires wide variations in speed with extremely close regulation when handling large amounts of power. It also involves the starting of large a-c motors without undue disturbance to power systems and the further problem of absorbing large slip losses of the motors such as to maintain high efficiency, and power factor without sacrificing the required speed regulation. The new drive described uses two 20,000-horsepower slip-ring induction motors, each with its own propeller, operating in synchronism without any mechanical connection. Speed control is obtained by impressing a controlled variable frequency on the secondaries of the motors while maintaining frequency on the primaries. Speed control is obtained by a combination of high-speed exciters and a potentiometer rheostat handling only a few watts of power.

42-67—Four-Winding Transformers; *T. C. McFarland (M'32). 20 cents.* Starting with the basic differential equations, working equations are formulated subject to the assumption that the exciting current is negligible. The equations are general and can be adapted to various types of problems. The procedure for the determination of constants is clearly outlined. The equivalent circuit is shown to evolve readily from the working equations. Application of the equations is made to typical examples, using per-unit values throughout.

42-68—Correction for Saturation; *T. C. McFarland (M'32). 15 cents.* It is generally agreed that the virtual or air-gap voltage of a salient-pole synchronous machine determines the saturation in the magnetic circuit. Studies have indicated that the major portion of the saturation occurs in the poles of such machines. Consequently, it is logical to apply a correction as a linear addition to the nominal or excitation-voltage vector of the two-reaction diagram drawn with unsaturated constants, in order to ascertain the actual per-unit excitation necessary under load conditions which produce a certain air-gap voltage. It is the purpose of this paper to present an analytical method for determining the necessary correction.

Industrial Power Applications

42-29—Electrical Drives for Wide Speed Ranges; *G. A. Caldwell (A'39) and W. H. Formhals (A'35). 15 cents.* The electrical drive for a wide speed range is obtained by the addition of a rotating regulator called a "Pilotrol" to a conventional variable voltage system. This combination will give a speed range of 120 to 1 and can be used effectively in many industries to simplify the mechanical design of the machine which it drives. This drive is especially useful for machine-tool feed drives where its use eliminates elaborate change-gear mechanism, clutches, and so on, and at the same time gives a more flexible control scheme with the complete speed range under the control of the operator without his leaving the work or stopping the machine. The various factors in machine design and the details of the circuit used to obtain the wide speed range are described.

42-32—A New Voltage-Regulating Relay Plus Line-Drop Compensator; *H. J. Carlin (A'41). 15 cents.* This paper describes a new type of voltage-regulating relay with line-drop compensator, which is economically applicable to low-capacity feeders in conjunction with the tap-changing type of feeder-voltage regulators. The device has selective timing response; that is, the greater the change in voltage, the faster the relay operates. The method of compensation in the relay is to correct for magnitude and phase angle of the line drop instead of for resistance and reactance drops as in the customary designs. Further, it is shown that two independent compensator adjustments are not always necessary. A determination of the errors involved indicates that with a proper relay design an

adjustment for magnitude of line drop alone gives satisfactory results for most applications. Finally, the performance of the relay is analyzed mathematically and checked experimentally to show how it satisfies the basic requirements of a voltage-regulating relay plus line-drop compensator.

Instruments and Measurements

42-70—Design of Long-Scale Indicating Instruments; *A. J. Corson (A'24), R. M. Rowell, and S. C. Hoare. 25 cents.* The scale length of electrical indicating instruments has in general been limited to 90 angular degrees, due to characteristic torque-deflection curves of the mechanisms used. The importance of longer scales is evidenced by the use of such scales on nonelectrical instruments, such as steam gauges, and by the production of several long-scale electrical instruments in England. This paper outlines the design factors involved in instruments having long scales and reviews the development of a complete group of $4^1/_4$- by $4^1/_4$-inch rectangular instruments having scale lengths of 240 angular degrees. This group includes all the instruments required by modern switchboards, namely a-c ammeters and voltmeters, d-c ammeters and voltmeters, a-c wattmeters, varmeters, frequency meters, power-factor meters, temperature meters, and synchroscopes. Data on accuracy, voltampere burdens, and general performance are presented.

42-71—Improvement in Modern Meter-Testing Technique; *Mark A. Princi (A'36) and Edward E. Lynch (M'35). 20 cents.* The art of factory testing of watt-hour meters, normally involving a series of cut-and-try repetitive operations, is shown in this paper to be reduced to a specific routine, which in addition to simplifying the calibration procedure and improving accuracy, permits maintenance of closer control of the over-all quality of the product. Such a routine is made possible through the use of the stroboscope within its practical limits, photoelectric methods of revolutions counting, and a novel system for obtaining simultaneous readings of watt-hour meter calibration accuracy at three load points. The selection and arrangement of testing apparatus is determined through a statistical study of product uniformity. The claims made for the system are supported by a continuous period of operation in actual service for about two years.

Land Transportation

42-49—A Control System for Modern Multiple-Unit Rapid-Transit Cars; *H. G. Moore (A'38). 15 cents.* This paper describes a control system utilizing a commutator-type rheostatic motor controller and providing a dynamic service brake as developed for PCC cars but now adapted to multiple-unit operation in rapid transit service. The principles underlying the control of series motors with particular reference to the switching and regulation of dynamic braking are presented. Special features provided to suit operating conditions incident to the type of service are described.

42-50—Modern Electrical Equipment for Industrial Diesel-Electric Locomotives; *Lanier Greer. 15 cents.* Modern electrical equipment for industrial Diesel-electric locomotives is different in many respects from that used six years ago. New and improved high-temperature insulating materials and modern synthetic varnishes have been developed and are used extensively today. These, together with new design constants, have made possible reduced weight per horsepower and an improved product. A method of generator excitation has been developed that assures positive control of the engine speed and power. The modern traction motor is multipole instead of the conventional four-pole design. It is mounted integral with a double-reduction gear unit completely enclosed in an oil-tight gear case. All bearings in the gear unit are antifriction, except those on the axle, and are oil lubricated. For slow-speed switching service, where high tractive efforts are important, double-reduction gearing shows better transmission efficiency than the conventional single-reduction gearing.

42-51—Progress in Development of Trolley-Coach Overhead Reflected in Higher Service Standards; *L. W. Birch (M'29). 20 cents.* The development of overhead materials for trolley-coach operation over the past 20 years has been concentrated mainly on:

1. Current collection
2. Hangers and insulation
3. Curve materials
4. Turnouts and crossovers

Improved current-collection equipment incorporating the carbon-insert shoe has been responsible for the reduction of wear on fittings and trolley wire. It has also been responsible for the complete elimination of trolley-wire lubrication formerly required for the all-metallic shoe collector. Improvements in insulated hangers have resulted in a more dependable distribution system and the elimination of considerable secondary insulation. The curve segment, available in any degree, is replacing the conventional pullover arrangement on all trolley coach overhead systems. Special assemblies for turnouts and crossovers use the same insulating units. These units have been strengthened both mechanically and electrically to meet the severe service on heavy lines. Automatic electrical equipment has been developed for all classes of turnouts. Today's trolley-coach overhead is mechanically stronger, electrically stronger, and responsible for very few dewirements.

42-52—PCC Car Operating Results in Pittsburgh; *W. J. Clardy (M'39). 15 cents.* The problem created by the decline in transit revenues during the depression led the Pittsburgh Railways Company to initiate a long range service betterment program. The most important phase of the plan was the use of modern street cars, as developed by the Presidents' Conference Committee, to replace the earlier types of rolling stock on the property. With 301 of these PCC cars in service and 100 additional units scheduled for early delivery, sufficient data are available to show exceptionally favorable operating results. Actual experience in service has demonstrated that car maintenance comes down 28 per cent, track and roadway maintenance drops 21 per cent, accidents decreased 25 per cent, the number of cars required for specific schedules is reduced 10 per cent, and revenues increase 8 per cent. This favorable outcome has caused continued expansion in the use of such equipment and established a superior urban transit service.

42-54—Single-Phase A-C Electric Locomotives on the Pennsylvania Railroad: Protection and Tonnage Ratings; *H. C. Griffith (M'35). 15 cents.* The electric locomotive contains electric apparatus which is subject to the usual hazards of similar equipment in other service and also to hazards introduced by the special requirements of railroad operation. Automatic and semiautomatic protective devices are required, and also indicating devices are needed to which attention must be directed during operation. In addition to these devices it is also necessary to predetermine the maximum loads which the locomotive can handle without overheating over each route in order to obtain the most efficient utilization and avoid damage to the equipment.

42-55—Electropneumatic Brakes for High-Speed Trains With Particular Reference to Their Electrical Features; *J. C. McCune. 20 cents.* This paper points out that a brake transforms mechanical energy into heat, or is a heat engine in reverse. It explains where time lags are encountered in pneumatic apparatus and how these time lags can be overcome by the use of electricity. It gives some illustrations of the importance of this time saving in facilitating the movement of high-speed trains. Finally, it describes several electrical arrangements not ordinarily met with.

42-56—Acoustics and the Quiet Train Ride; *William A. Jack. 30 cents.* This paper discusses those fundamentals of acoustics which are important in attacking practical problems in noise reduction. A description is given of the instruments suitable for measuring the physical quantities involved. The train problem is analyzed and data taken by the author on a relatively quiet type of coach are presented. The various methods of noise control that may be applied to a coach are discussed and data are presented indicating the possibilities of each method.

Power Generation

42-36—Synthetic or Equivalent Load-Curves; *R. F. Hamilton* (*M'18*). *30 cents.* This paper describes short approximate methods for the solution of several types of intangible problems which require load-curve analyses. Laborious effort may be expended in compiling results from a group of curves without greater precision than is believed possible to obtain from the use of one or a few synthetic curves which combine the characteristics under investigation, and permit the determination of such items as peak loads, losses, and required capacities of equipment. An effort is made to reduce load curves to fundamental elements. Examples are given which demonstrate application to equipment losses and capacities, transmission-line losses, load factors and demand factors for combinations of loads and relations between demands of various durations.

42-53—Facilities for the Supply of Kilowatts and Kilovars; *H. K. Sels* (*M'29*) *and Theodore Seely* (*A'41*). *20 cents.* Increased system kilowatt capacity may be realized by the reduction of generator kilovar requirements and the provision of reactive capacity sources at other points in the system. The factors to be considered in the choice of various reactive sources are discussed. Benefits to be realized from the various reactive sources are described. The paper is based upon system-plan studies of a large eastern utility.

42-72—Control of Tie-Line Power Swings; *C. Concordia* (*M'37*), *H. S. Shott* (*A'40*), *and C. N. Weygandt* (*A'37*). *25 cents.* The general requirements of load, frequency, and time-error corrective equipment, which is used to modify the prime-mover speed-governor responses initiated by system-load changes, are given in a companion paper by Messrs. Crary and McClure. Effects of speed-governor characteristics on the system frequency stability and the magnitudes of tie-line power swings have been analyzed previously. The object of the present analysis, which includes the additional effects of tie-line power control, is to determine the desirable controller characteristics with respect to the maximum effectiveness in reducing tie-line power swings during periods of large variable loads. Of the three types of controllers studied, one applies a continuous adjustment proportional to tie-line power deviation; another applies a continuous adjustment at a rate proportional to the power deviation; and a third applies intermittent adjustments at regular time intervals. The results of stability calculations and of the differential analyzer solutions of the equations indicate that:

1. The optimum rate of tie-line power correction is not much less than the maximum allowable value dictated by stability limitations.
2. The optimum rate for minimum tie-line power deviation is considerably greater than that ordinarily used in power-system control.
3. The two types of continuous controllers have approximately the same effectiveness if the optimum characteristics of each are used.
4. The use of a continuous controller allows a faster rate of correction than can be tolerated with intermittent control.

42-73—Supplementary Control of Prime-Mover Speed Governors; *S. B. Crary* (*M'37*) *and J. B. McClure* (*A'29*). *15 cents.* The development of interconnected systems has required improvements in the manual and automatic control of load, frequency, and time. The speed governors of the prime movers have always provided the medium for supplementary control of frequency, load, and time. This paper presents what appear, from analysis and experience, to be logical conclusions as to the proper characteristics and functions of the supplementary control devices, and is a companion paper to the one by Concordia, Weygandt, and Shott, presenting the results of an analysis of tie-line control. The problems of load, frequency, and time control have usually been treated as related to the operating problems of particular systems. This paper has as its purpose a discussion of the various factors that apply more generally for all types of systems.

Power Transmission and Distribution

42-30—Field Tests on High-Capacity Air-Blast Station-Type Circuit Breakers; *H. E. Strang* (*M'39*) *and W. F. Skeats* (*M'36*). *15 cents.* This paper describes a 1,500,000 kva 15-kv air-blast circuit breaker tested at the Hell Gate station of the Consolidated Edison Company, explains the synthetic circuit by means of which factory tests were made to give preliminary assurance of the breaker's ability to handle its rating satisfactorily, tabulates the results of the field tests, and shows photographs of the contacts and interrupting chamber after test. In the field tests, the breaker confirmed the assurances given by the synthetic tests made in the factory, clearing seven short circuits at duties from 40 to 100 per cent of rating with an arc duration never exceeding one-half cycle.

42-31—Analysis of the Application of High-Speed Reclosing Breakers to Transmission Systems; *S. B. Crary* (*M'37*), *L. F. Kennedy* (*M'39*), *and C. A. Woodrow* (*M'41*). *30 cents.* Considerable technical application information has been presented to aid in the general understanding and use of high-speed relays, high-interrupting-speed breakers, ground-fault neutralizers, expulsion gaps, and high-speed reclosing breakers. Although many successful applications of high-speed breaker reclosing have been made in recent years, there still appears to be a real need for an analysis of the general possibilities and limitations of high-speed reclosing of both the three-phase and the single-phase types. The paper includes results of analysis for several typical system arrangements and conditions. These include effect of system inertia, line length, intermediate switching stations, types of faults, fault duration, and de-energization time. Conclusions are drawn as to the general benefits to be realized from reclosing and data presented to show the general conditions favorable to the use of various types of reclosing equipment.

42-35—Relays and Breakers for High-Speed Single-Pole Tripping and Reclosing; *S. L. Goldsborough* (*A'24*) *and A. W. Hill* (*M'41*). *15 cents.* The advantages of fast reclosure of transmission-line circuit breakers have been realized for a number of years. A recent improvement replaces the usual three-pole trip and reclosure operation by a single-pole operation. On single-phase-to-ground faults only the faulty phase conductor is tripped at each end of the line section and then immediately reclosed. The principal relay problem introduced by this type of operation concerns a method of indicating which phase conductor supplies the ground current. A prime requirement is that the sensitivity of the phase-selection method should match the sensitivity of the conventional residual-type ground relay. This sensitivity requirement calls for a selection method energized by electrical quantities which do not appear during normal load conditions. An inspection of the negative- and zero-sequence system vectors for single-phase-to-ground faults will reveal that the zero-sequence vectors take different positions (by 120 degrees) with respect to the negative-sequence vectors, depending upon which phase wire is faulted. Advantage is taken of this fact in evolving a relay composed of three selector elements similar to a conventional directional element.

42-37—The Influence of Towers and Conductor Sag on Transmission-Line Shielding; *R. W. Sorensen* (*F'19*) *and R. C. McMaster* (*A'37*). *20 cents.* This paper presents additional data, as determined by surge tests on models, relating to the protection of transmission lines from lightning. The procedure followed in conducting the tests was the same as that developed and reported in "Shielding of Transmission Lines" and "Shielding of Substations." This paper adds to the data previously obtained for protection provided by overhead ground wires, because the data in this paper shows tests made with model towers in the test area and with line sag. The paper also includes correction factors, to be applied to the data in the other papers, for the shielding effect of towers as a function of span length and indicates the added protection resulting from conductor sag. Detailed curves of the distribution of stroke terminations between ground wire, conductor, tower, and ground plane are given for strokes from varying positions of a cloud electrode at five times the height of transmission tower, a practical minimum cloud height that gives conservative shielding results.

42-42—Power Supply to Distribution Substations in War Time; *H. P. St. Clair* (*M'29*). *20 cents.* To meet the needs of the present war situation, ways and means must be found to obtain more capacity from existing distributing systems as well as to expand present facilities with the most effi-

cient use of materials and labor. Since it will become more and more necessary to load equipment beyond conventional limits, it is desirable to examine the possibilities that exist in various parts of the system for carrying such overloads with reasonable safety. Some of these possibilities, as applied to transmission substations and subtransmission systems, both for increased loading of existing facilities, as well as for maximum economy of material and labor in extending present facilities, are discussed in this paper.

42-45—Overhead Distribution Systems in War Time; *Harold Cole (M'27). 15 cents.* This paper points out the most practical ways of conserving material vital to the national-defense program. In general, it can best be accomplished by keeping to a minimum the quantities used to make the necessary line extensions and system reinforcements. Among the promising tools available to reduce the quantities of conductor material required are capacitors, voltage regulators, and boosters. Rearrangement of existing facilities so as to use them more effectively is also a possibility. The increased loading of existing lines and equipment also offers an effective means of postponing the need for system reinforcement without serious economic consequences. Wider limits of voltage regulation will be necessary and should be permissible if the shortage of materials becomes very critical. The adoption of methods of salvaging material removed from the system so as to get the maximum recovery for use on new constructions is an imperative need.

42-60—Electric-Power Distribution Systems in War Time; *Philip Sporn (F'30). 15 cents.* This paper is an introduction to four other companion papers which deal specifically with the distribution system supply, the substations themselves, the underground system, and overhead distribution system. It points out the importance of the distribution system in war time and suggests that present-day concepts of standards of the distribution system may well be altered materially to carry electric-power loads imposed by war conditions. A number of things can be done to the existing distribution systems under war-time conditions that would not usually be done under normal peace-time conditions. The object and scope of the symposium are to offer and discuss methods of obtaining more electric output from existing systems; building new systems and extensions at a minimum cost; economies in the use of materials; and some of the economic features involved. Particularly important is a consideration of the necessity of maintaining as high standards of service under war-time conditions as in normal times. Considerable elasticity has been built into existing systems which may well be used now in war time to economic advantage and with appreciable savings in the country's supply of critical materials, equipment, and labor.

42-61—Distribution Substations and War-Time Necessities; *F. C. Poage (M'38) and M. W. Reid. 15 cents.* Increased loads and priorities resulting from the war effort promise to place critical demands upon many substations. Means are suggested for fully utilizing and increasing load-carrying capabilities of existing transformers, regulators, circuit breakers, and other circuit elements. Simplification of circuit arrangement, addition of new circuits, decrease of breaker duties, release of equipment needed elsewhere, scheduling of maintenance, and reduction in load current by means of capacitors and off-peak load schedules are discussed. Use of alternate or substitute materials, simplified switching arrangements, adequate insulation levels, three-phase transformers, and single-unit substations are suggested for new substations. Strategic location and proper care of reserve equipment, periodic inspection, and thorough preventive maintenance are suggested. Review of fire and lightning protection is advised. Adequate training and rehearsal of operating personnel in the handling of emergencies are urged.

42-62—Underground Distribution Systems in War Time; *L. R. Gaty (A'39). 20 cents.* The underground distribution system is reviewed with particular reference to service hazards and to increased loading of cables and duct lines. Known information is summarized and additional data given on cable rating and the thermal loading of duct banks and on the time-temperature characteristics of cable in duct. Temperature variation which determines cable movement is indicated as having a greater effect on the life of lead-covered cable than the absolute temperature level; data is given on the temperature range for various peak loads and load factors. Suggestions are made of ways to obtain the maximum rating with the minimum cable damage. Test data are given on the rating of a subway switch with a method to increase this rating. Subway transformer ratings and ways to obtain increased ratings are discussed. The importance of conserving and salvaging material is stressed as well as the necessity of maintaining an adequate inspection program and records of performance. A list is given of conditions which should be investigated and recorded for present operation and future design.

42-74—Lightning Investigation on Wallenpaupack–Siegfried 220-Kv Line of Pennsylvania Power and Light Company; *Edgar Bell and F. W. Packer (M'41). 20 cents.* From 1926 to 1941 the Wallenpaupack–Siegfried line has served as a "guinea pig" for lightning research and it can claim a large share of the credit for establishing the direct stroke theory of lightning and proving the efficacy of overhead ground wires and necessity for low tower footing resistance for protecting transmission lines against lightning. A large part of the available data on lightning potentials, switching potentials, lightning-surge-voltage attenuation, lightning-surge-voltage wave shapes, and lightning-stroke currents were obtained on this line by use of field laboratories equipped with cathode-ray oscillographs, and large numbers of inexpensive automatic recording devices for recording voltages, currents, field gradients, and insulator flashovers. Careful correlation of line-tripout and insulator-flashover records with dynamic fault-current measurements and research measurements have made this investigation highly successful. The step-by-step application of overhead ground wires and buried tower-footing grounding cables is described, including the newer design in which, by use of lighter-weight cables and less stringing tension, the strengthening of structures and excessive vibration of overhead conductors was avoided. The 13-year perfect record for the High Knob continuous buried counterpoise, and ease of installation are cited among the reasons for installation of 37 additional miles of continuous counterpoise. The performance of the line in terms of lightning tripouts per year per kind of protection in use is given, and the entire absence of lightning trouble since lightning protection has been completed is mentioned.

Protective Devices

42-26—High-Capacity Circuit-Breaker Testing Station; *J. B. MacNeill (M'36) and W. B. Batten (A'28). 15 cents.* To test adequately circuit breakers of the largest interrupting ratings, the Westinghouse Electric and Manufacturing Company has enlarged its high-power laboratory. The second 60,000-kva generator provided for in the previous designs of the laboratory has been built and put in operation, thereby raising the first cycle short-circuit output to about 2,000,000 symmetrical kva. Additional power transformers for use with the new generator are overinsulated so that they may be used in series with the older transformers. This extends the available test voltage to 345 kv three phase or 396 kv single phase with the neutral grounded. The new arrangement facilitates testing by providing accurate control and great flexibility.

42-28—Distribution-Type Lightning Arrester Performance Characteristics; *Lightning Arrester Subcommittee. 15 cents.* Performance characteristics of modern distribution-type lightning arresters are presented by the lightning arrester subcommittee, in a report which brings up to date similar data given in a report published in *AIEE Transactions*, volume 56, 1937 (May section), pages 576–7. Since 1937 there have been some changes in distribution arresters. There has also been a growing need for additional information relating to the volt-time curve of arrester breakdown, and discharge voltages for higher discharge currents than previously given. Tabulated values of minimum, average, and maximum impulse-voltage arrester breakdown are given, from tests on arresters using the rates of voltage rise specified in the Lightning Arrester Standards, bulletin 28, ASA Standard *C*-62. Minimum, average, and maximum crest values of *IR* discharge voltages are also given for discharge currents of

1,500, 3,000, 5,000, 10,000, and 20,000 amperes crest, all on a 10x20-microsecond current wave. To enable rapid interpretation, this data has been plotted in curve form. Volt-time curves of impulse breakdown voltage are also given for the various arrester ratings. By comparing the volt-time characteristics of the insulation to be protected with the volt-time characteristics of the arrester, an evaluation can be made of the margin of protection.

42-38—A Fast Circuit Breaker; *D. I. Bohn (M '41) and Otto Jensen (A '41). 15 cents.* Recent large installations of mercury-arc rectifiers has shown the importance of proper protection of the d-c as well as the a-c system. The desirability of an extremely high-speed circuit breaker inserted between the rectifier anodes and its corresponding transformer terminal have been clearly demonstrated by actual operation. The paper describes the mechanical design and electrical characteristics of an anode circuit breaker with an operating speed of one-quarter cycle to the peak of the short-circuit current.

42-39—Transient Characteristics of Current Transformers During Faults; *C. Concordia (M '37), C. N. Weygandt (A '37), and H. S. Shott (A '40). 25 cents.* Current transformers supplying power-system protective relays may be subjected to large currents which produce very high degrees of saturation and consequent ratio errors during faults. It is essential for proper relay and current-transformer application to know what these errors may be. This paper presents quantitative data, obtained on the differential analyzer, on the error currents over a range of transformer size and fault current. The errors are classified according to the type of relay that can be applied and also according to the d-c time constant of the circuit considered.

42-40—Linear Couplers for Bus Protection; *E. L. Harder (M '41), E. H. Klemmer, W. K. Sonnemann (A '38), and E. C. Wentz (A '28). 25 cents.* A scheme of bus protection offering advantages in simplicity, speed and size uses linear couplers (air-core mutual reactances) in place of current transformers. This solves the troublesome problem of saturation and provides a linear relationship between secondary voltage and primary current. The coupler secondaries for a given bus are connected in a series loop with the relay. When the currents entering and leaving the bus are equal, the net induced voltage in the relay loop is zero. For a fault on the bus, however, the net induced voltage, proportional to the fault current, operates the relay. The problems are:

(1) To utilize effectively the smaller available energy

(2) To build couplers of sufficiently equal mutual reactance and unaffected by stray fields.

A toroidal coil solved the latter problem. Thorough tests have shown that the performance is strictly linear with respect to primary current, practically unaffected by the primary d-c transient, and thus can be calculated accurately and simply.

42-41—A Two-and-One-Half-Million-Kva Compressed-Air Powerhouse Breaker; *L. R. Ludwig (M '41), H. M. Wilcox (M '27), and B. P. Baker (M '41). 20 cents.* Compressed-air circuit breakers utilizing the cross-blast type of interruption for heavy-duty powerhouse service at generating voltages are presented with a discussion of theory as applied to heavy current interruption. Continuing the discussion in an earlier paper which recorded data justifying the application of such breakers in service up to $1^1/_2$ million kva, test data are here presented justifying such application in the heaviest present-day powerhouse service, together with a discussion of the effect of circuit voltage recovery rates. Conclusions are drawn as to the adaptability of these breakers to switching service.

42-66-ACO—Back-Up Protection of the Boulder Dam–City of Los Angeles Transmission Line; *C. P. Garman (M '26) and L. F. Kennedy (M '39). 15 cents.* This paper discusses the requirements of a back-up protection system as regards both the type of failure and the arrangement of system connections. Where the system layout includes bus-sectionalizing switches it is important that the back-up protective equipment open such of these switches as are necessary in order that the system as a whole may continue to give the highest possible continuity of service. A description of the Boulder–Los Angeles interconnection is given, together with a discussion of the need to maintain this interconnection. The reasons for the choice of a particular system of back-up protection and the method of operation are described. The back-up system as applied permits retaining the tie between Boulder Dam and Los Angeles even in case of the remote possibility of some protective equipment failure.

STANDARDS • • •

Transformer Standards Being Revised

In March 1940, the proposed Standards for Transformers, Regulators, and Reactors (American Standards Association C-57) were published for a year's trial use. Since that time, many changes of a technical nature have been proposed. These changes and additions include test methods, requirements for impulse testing, and tests and levels required at the neutrals of transformer banks. These subjects and many others have been given consideration by the transformer subcommittee of the AIEE committee on electrical machinery, and recommendations regarding them have been transmitted to the ASA C-57 committee, preparatory to issuance of a revised approved standard. It is not possible, however, at the present time to state the date of issue of a revised edition.

PERSONAL • • • •

J. B. Whitehead (A'00, M'08, F'12) professor of electrical engineering and director of the school of engineering of The Johns Hopkins University, Baltimore, Md., has been awarded the Edison Medal for 1941 "for his contributions to the field of electrical engineering, his pioneering and development in the field of dielectric research, and his achievements in the advancement of engineering education." Born August 18, 1872, he received from Johns Hopkins University the degrees of electrical engineer in 1893, bachelor of arts in 1898, and doctor of philosophy in 1902. From 1893 to 1896 he was employed by the Westinghouse Electric and Manufacturing Company. After a brief interval with the Niagara Falls Power Company, he returned to Johns Hopkins University as instructor in applied electricity, 1897–1900. He was associate instructor from 1901 to 1904 and associate professor from 1904 to 1910, when he became professor. He was active in the establishment of the school of engineering at Johns Hopkins in 1912, being made professor of electrical engineering at that time and becoming dean of the school of engineering in 1919 and director in 1938. He was research assistant in 1902 for the United States Bureau of Standards, and from 1902 to 1905, for the Carnegie Institution of Washington, working in the Johns Hopkins Laboratories. During 1926–27 he was an exchange professor to France, where he represented the Institute as delegate to the International Conference on large High-Voltage Electric Systems. Since 1900 he has been engaged in research and general consulting in electrical engineering. He is the author of many books and articles chiefly on high-voltage insulation, and is the inventor of the Corona Voltmeter. He was president of the Institute 1933–34, and a manager (1924–28) in addition to having been a founder and chairman of the Baltimore Section (now the Maryland Section). He has served as a member of many committees and as chairman of several. He is also a member of the National Academy of Sciences, American Physical Society, National Institute of Social Sciences, American Association for the Advancement of Science,

J. B. Whitehead

as well as Phi Beta Kappa and Tau Beta Pi. He has received the Edward Longstreth Medal and the Elliott Cresson Gold Medal of the Franklin Institute, was twice awarded the Triennial Prize of the Institute Elektrotechnique Montefiore, Liege, Belgium, in addition to being honored by the University of Nancy, France.

R. F. Hays, Jr. (A'36) research laboratories of the Sperry Gyroscope Company, Garden City, L. I., has been awarded the Alfred Noble Prize for 1940–41 for his paper entitled "Development of the Glow Switch" [*AIEE*

R. F. Hays, Jr.

Transactions, volume 60, 1941 (May section), pages 223–5]. Born March 27, 1914, Philadelphia, Miss., he received the degree of bachelor of science in electrical engineering from Mississippi State College in 1935. For brief intervals during 1935–36 he was compliance supervisor in charge of cotton acreage survey under the Agricultural Adjustment Administration in Neshoba County, Miss., electrical engineer for the Reynolds Lumber Company, Deemer, Miss., and draftsman for the Mississippi State Highway Department at Jackson. During 1936–37 he was assistant instructor in physics at Mississippi State College. In 1937 he was employed by the Westinghouse Lamp Division, Bloomfield, N. J., as vapor-lamp development engineer where he remained until 1941 when he joined the research laboratory of the Sperry Gyroscope Company. He has been granted six patents and has written several technical papers.

Simon Ramo (A'40) electrical engineer, general engineering laboratory, General Electric Company, Schenectady, N. Y., has been given honorable mention by Eta Kappa Nu, honorary electrical engineering society, in its recognition of the outstanding young electrical engineer for 1941. Born May 7, 1913, Salt Lake City, Utah, he received the degree of bachelor of science in electrical engineering from the University of Utah in 1933 and that of doctor of philosophy from California Institute of Technology in 1936. He was a teaching fellow in the electrical engineering department at California Institute of Technology, Pasadena, 1934–36. He entered the General Electric test course in 1936, first on cathode-ray-oscillograph design and since 1937 carrying on research in high frequency and electronics and lecturing in the company's advanced engineering courses. He is also a member of Tau Beta Pi, Sigma Xi, and the Institute of Radio Engineers.

D. W. McLenegan (A'24, M'31) manager of engineering sales in the air-conditioning and commercial refrigeration department of the General Electric Company, Bloomfield, N. J., has been appointed engineer in charge at the Bloomfield Works. In 1921 he graduated from the University of Wisconsin, Madison, with the degree of bachelor of science in mechanical engineering and was instructor in engineering mathematics there in 1921–22. He joined the General Electric Company, Schenectady, N. Y., in 1922, working on mechanical and electrical development in the research laboratory, and in 1923 transferred to the industrial engineering department. After assisting in advance work leading to the formation of the company's air-conditioning department, Bloomfield, he joined that department in 1932, serving successively in the commercial, commercial engineering, and engineering design sections. He was made manager of the air-conditioning institute in Bloomfield in 1938 and the following year, manager of engineering sales in the air-conditioning department, in the new divisional organization set up after the consolidation of the air-conditioning and commercial refrigeration departments.

J. W. McNairy (A'26) assistant to the manager in charge of engineering at the General Electric Company, Bridgeport, Conn., has been appointed assistant manager of the Bridgeport works. In 1917 he was graduated from North Carolina State College with the degree of bachelor of science in electrical engineering and entered the testing department of the General Electric Company, Schenectady, N. Y. After an interval of army service, he returned to the General Electric Company, joining the meter and instrument commercial department. He was later transferred to similar work in the West Lynn, Mass., plant, but returned to Schenectady in 1920 to enter the railway department, moving with it to Erie, N. Y., in 1927. He became assistant design engineer of the control division of the transportation department in 1928, remaining until he was transferred to the Bridgeport works in 1940. He has twice been the recipient of the Charles A. Coffin award, for the invention and development of an electrically operated flow meter and of a high-speed air circuit breaker for railway feeder circuits.

G. F. Corcoran (M'33) former professor of electrical engineering at the State University of Iowa, Iowa City, has been appointed chairman of the department of electrical engineering at the University of Maryland, College Park. Born September 26, 1900, at Redfield, S. Dak., he received the degree of bachelor of science from South Dakota State College in 1923 and that of master of science from the University of Minnesota, Minneapolis, in 1926. He was an instructor in electrical engineering there in 1927, and at Kansas State College, Manhattan, in 1928 where he became an assistant professor of electrical engineering in 1930. He became associate professor of electrical engineering at the State University of Iowa, advancing to the position of professor there in 1939. He is the author of numerous articles and books on engineering subjects.

Chester Lichtenberg (A'05, M'13) staff assistant at the General Electric Company, Fort Wayne, Ind., has been appointed administrator of product quality to act as co-ordinator between the manager of the plant and Government inspectors in connection with defense supplies. After graduating from Columbia University with the degree of electrical engineer in 1906, he did research at the university and in 1907 entered the testing department of the General Electric Company, Schenectady, N. Y. In 1909 he was transferred to the engineering department. Following army service 1917–20, he returned to the department of automatic stations of the General Electric Company, Schenectady. He spent a brief period at the company's plant in Philadelphia, Pa., before going to Fort Wayne in 1931 as engineer in charge of commercial refrigeration.

H. H. Weber (A'27, F'40) commercial engineer of the United States Rubber Company, N. Y., has been awarded an honorary life membership in the International Municipal Signal Association.

OBITUARY • • • •

Frank Conrad (A'02, F'37), assistant chief engineer of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., died December 10, 1941. Born May 4, 1874, at Pittsburgh, Pa., he was educated there and entered the Westinghouse Electric Company, Pittsburgh, Pa., in 1890, working in the shop on meter manufacture. He worked successively in the service department, factory inspection department, later was put in charge of design of switchboards, meters, rheostats and in 1897 completed the redesign of the Shallenberger meter. In 1904 he become general engineer doing special development work and in 1910 was assigned to work on development of electrical equipment for starting and lighting automobiles. In 1912 he began investigation of radio telegraphy and telephony, in 1914 working on special development for the War and Navy Departments. In 1919 he began broadcasts of programs over his experimental radio station and in 1920 designed and supervised the construction of the Westinghouse Radio Station, KDKA. In 1921 he was placed in

charge of all radio developments, and was appointed assistant chief engineer of the company in that year. Since 1923 he had been engaged in the development of ultra-high radio frequencies and short wave broadcasting among other research projects. He held many patents for electrical and radio devices. He was given the honorary degree of doctor of science by the University of Pittsburgh in 1928. He was awarded the Morris Liebman prize by the Institute of Radio Engineers in 1926, the John Scott Medal by the city of Philadelphia in 1933, the Edison Medal in 1931, and the AIEE Lamme Medal in 1936. He was also a member of the Institute of Radio Engineers, Society of Automotive Engineers, and American Association for the Advancement of Science.

Hubert Vinton Carpenter (A'03, F'18) dean of the college of mechanic arts and engineering and director of the engineering experiment station, State College of Washington, Pullman, died on November 15, 1941. Born January 29, 1875, near Mt. Carroll, Ill., he received from the University of Illinois the degrees of bachelor of science in electrical engineering in 1897 and master of science in mathematics and physics in 1899, and in 1938 the degree of doctor of laws from the State College of Washington. From 1897 to 1899 he was an assistant in physics at the University of Illinois, Urbana, and an instructor from 1899 to 1901, when he was appointed assistant professor of physics and electrical engineering at the State College of Washington. Two years later he became head of the department of mechanical and electrical engineering and in 1917 he assumed the position as dean of the college of mechanic arts and engineering. In 1919 he became director of the experiment station. He obtained a leave of absence in 1935–36 in order to act as consultant for the Pacific Northwest Regional Planning Commission. He did much to develop the college radio station, KWSC, having designed, built, and assembled its equipment in addition to being its first program and technical director. The author of a number of technical articles, in 1939 he published a textbook, "Electrical Transmission and Distribution of Power". He also furthered developments in electrical measuring instruments and water wheel regulating devices. He was a vice-president of AIEE from 1930 to 1932 and had served on the committee on code of principles of professional conduct since 1936, having been chairman 1936–38. He served on the committee on education 1931–39 and the special committee on Institute activities during 1936–37. He was also a member of the Society for the Promotion of Engineering Education, the American Society of Mechanical Engineers, Tau Beta Pi, and Sigma Xi.

Charles George Ridgely Kemp (M'34) electrical engineer in charge of the design of power plants, substations, and transmission lines for the Atlantic Service Utility Corporation, Reading, Pa., died on November 3, 1941. Born in Baltimore, Md., September 16, 1882, he attended Baltimore Polytechnic Institute and Westinghouse Technical Night School. In 1905 he entered the testing department of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. Except for an interval of several years spent in electrical construction work in the United States and Brazil, he continued to work for the Westinghouse company, in 1911 transferring to the Philadelphia sales office to engage in engineering and sales work. In 1922 he joined W. S. Barstow and Company, Reading, Pa., as electrical engineer in charge of all electrical designs for power houses, substations, and switching stations, and in 1933 he became electrical engineer in charge of the design of power plants, substations, and transmission lines for the E. M. Gilbert Engineering Corporation, Reading, Pa. From 1938 to 1941, he was engaged in similar work with the Utility Management Corporation, Reading, Pa., and early in 1941 he joined the Atlantic Utility Service Corporation. He has been responsible for the design of many electrical stations in the United States and the Philippine Islands. He was also a member of the Pennsylvania Society of Professional Engineers.

William Nathan Gladson (A'98, M'02) dean emeritus of the college of engineering and vice-president emeritus of the University of Arkansas, Fayetteville, died October 18, 1941. Born February 22, 1866, in Corning, Iowa, he received the degrees of bachelor of mechanical engineering from Iowa State College, Ames, in 1888, doctor of philosophy in electrical engineering from McClemorsville College, in 1911, and the honorary degree of doctor of engineering from the University of Arkansas in 1938. He was employed by the Thomson-Houston Electric Company, Chicago, Ill., as engineer from 1888 until 1892 when he became assistant professor of electrical engineering at Ohio State University. During 1893–94 he was employed by Westinghouse Electric and Manufacturing Company at the Chicago World's Fair. In 1894 he became professor of electrical engineering at the University of Arkansas and in 1913 was appointed dean of the college of engineering and vice-president of the university, serving until his retirement in 1936. He was made emeritus vice-president and dean of the college of engineering in 1937. He was engineer in charge of the Arkansas Water Power Survey 1909–10, a member of the Naval Consulting Board 1917–18, and carried on consulting practice from 1917 until 1938. He was president of the Arkansas State Board for Engineering Registration and a member of the Arkansas State Utilities Commission, Society for the Promotion of Engineering Education, Arkansas Engineers Society, and Tau Beta Pi.

Ernest Irwin (A'12) general agent of Associated Telephone Company, Ltd., Santa Monica, Calif., died on November 3, 1941. He was born in Knox, Pa., April 21, 1882. Following a brief period in 1898 in the electrical department of the Solvay Process Company, Detroit, Mich., he worked for both the Syracuse Telephone Company and Central New York Telephone Company, Syracuse, N. Y. In 1903 he was employed by the Home Telephone Company, Los Angeles, Calif., and in 1904 as wire chief by the Pomona Valley Home Telephone Company. Becoming wire chief in charge of plant development for the Southwestern Home Telephone Company, Redlands, Calif., in 1907, he carried on this work for eleven years. In 1920 he was appointed secretary of the California Independent Telephone Association, a year later joining the California Railroad Commission as assistant engineer. In 1923 he resumed his position with the Independent Telephone Association and remained as secretary until 1940, when he was appointed engineer by the Association. In 1929 he also joined the Associated Telephone Company, Ltd., as assistant to the president, later becoming general agent for the company. He also was a member of the United States Independent Telephone Association, the Independent Pioneer Telephone Association, and the Pacific Coast Electrical Association.

John Theodore Walther (A'19, M'26) head of the electrical engineering department of the University of Akron, died on November 4, 1941. Born October 25, 1886 in Tawas, Mich., he was graduated in 1909 from the University of Michigan with the degree of bachelor of science in electrical engineering. He worked with the Westinghouse Electric and Manufacturing Company in East Pittsburgh, Philadelphia, and Cleveland, in the engineering and sales departments until 1917 when he joined the Massillon Gas & Electric Company, Massillon, Ohio, as power sales engineer. During that year he worked for the Firestone Tire and Rubber Company, Akron, Ohio, as electrical engineer in charge of testing and later transferred to the Firestone Steel Products Company, Rim Plant, of Firestone Tire and Rubber Company, as electrical engineer in charge of laying out the switchboard and all wiring of the new plant. In 1920 he became an instructor of electrical engineering at the University of Akron and later professor of electrical engineering, being appointed head of the engineering department there in 1923. He had been counselor of the AIEE Student Branch there since 1930. He was also a member of the Society for the Promotion of Engineering Education.

James B. Marquis (A'20) retired owner and manager of an independent telephone company at Norwich, N. Y., died on June 5, 1941. Born in Norwich on October 9, 1862, he was educated there. In 1894 he began construction and operation of an independent telephone system in Norwich, continuing until 1920. He pursued in-

dependently extensive research in physics and evolved a theory of electrical elements in matter which was published in 1938 in a pamphlet entitled "The Electrical Elements and Neutrons as Closed Systems of Moving Matter."

MEMBERSHIP • •

Recommended for Transfer

The board of examiners, at its meeting on December 18, 1941, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the national secretary.

To Grade of Fellow

MacGahan, Paul, development engineer, Westinghouse Electric and Manufacturing Company, Newark, N. J.

To Grade of Member

Ackerlind, E., assistant engineer, Naval Research Laboratories, Anacostia Station, Washington, D.C.
Bishop, J. W., head, electrical department, Edison Institute, Dearborn, Mich.
Braunig, V. H., superintendent, electrical department, San Antonio Public Service Company, San Antonio, Tex.
Brunner, C. F., electrical engineer, Metropolitan Engineering Company, Brooklyn, N. Y.
Chennault, W. S., chief operator, Western Union Telegraph Company, Sweetwater, Tex.
Codling, E. P., supervisor, methods, tools, equipment, Westinghouse Electric and Manufacturing Company, Lima, Ohio
Ellis, H. E., electrical design engineer, Westinghouse Electric and Manufacturing Company, Lima, Ohio
Ewald, G. A., engineer, Public Service Electric and Gas Company, Newark, N. J.
Fricker, W. R., district service engineer, Canadian Westinghouse Company, Regina, Sask.
Hodgins, H. B., Spokane representative, Westinghouse Electric and Manufacturing Company, Spokane, Wash.
Osborn, R. E., instructor of electrical engineering, Cornell University, Buffalo, N. Y.
O'Sullivan, G. H., assistant electrical engineer, J. G. White Engineering Corporation, New York, N. Y.
Sharp, S. M., chief engineer, Southwestern Gas and Electric Company, Shreveport, La.
Thein, L. P., professor of physics, St. Mary's University, San Antonio, Tex.
Woodward, M. W., research and field engineer, Commercial Radio Equipment Company, Kansas City, Mo.

15 to grade of Member

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Names of applicants in the United States and Canada are arranged by geographical District. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the national secretary before January 31, 1942, or March 31, 1942 if the applicant resides outside of the United States or Canada.

United States and Canada

1. North Eastern

Ballard, R. G., General Electric Company, West Lynn, Mass.
Bradford, C. I., Remington Arms Company, Bridgeport, Conn.
Clymer, C. C. (Associate re-election), General Electric Company, Schenectady, N. Y.
Conover, W. B., General Electric Company, Pittsfield, Mass.
Hoare, S. C. (Associate re-election), General Electric Company, Lynn, Mass.
Jackson, J. Y., General Electric Company, Lynn, Mass.
Pattee, J. R. (Member), Bristol Company, Waterbury, Conn.
Popovich, B. (Member), Curtiss Wright Corporation, Buffalo, N. Y.
Rowell, R. M., General Electric Company, Lynn, Mass.
Single, J. F., Jr., Southern New England Telephone Company, New Haven, Conn.
Smith, J. P., General Electric Company, Schenectady, N. Y.
Stork, C. L., Eastman Kodak Company, Rochester, N. Y.
Turner, E. N., General Electric Company, Pittsfield, Mass.

2. Middle Eastern

Bartlett, C. O., United States Army, Aberdeen Proving Ground, Md.
Bauer, C. H., Consolidated Gas, Electric Light and Power Company, Baltimore, Md.
Bourland, L. T. (Member), Naval Research Laboratory, Washington, D. C.
Claggett, T. J., Pennsylvania Water and Power Company, Baltimore, Md.
Cooter, I. L., National Bureau of Standards, Washington, D. C.
Downs, D. G., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Dursi, G. A. (Member), Pennsylvania Transformer Company, Pittsburgh, Penna.
Emmens, M. L. (Member), A. L. Garber Company, Ashland, Ohio.
Fitzgerald, J. A., University of Dayton, Dayton, Ohio.
Fraps, A. W., General Electric Company, Philadelphia, Pa.
Gemmell, I. S., Bethlehem-Sparrows Point Shipyard, Incorporated, Sparrows Pt., Md.
Giannetto, C. (Member), Cincinnati Milling Machine Company, Cincinnati, Ohio.
Green, L. E., Bethlehem Sparrows Point Shipyard, Inc., Sparrows Point, Md.
Greer, L. (Member), General Electric Company, Erie, Pa.
Headley, C. L., Consolidated Gas, Electric Light and Power Company, Baltimore, Md.
Herold, J. A., Consolidated Gas, Electric Light and Power Company, Baltimore, Md.
Howard, D. G., Jr., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Keagy, J. H., General Electric Company, Philadelphia, Pa.
Klemmer, E. H., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Lawrence, G. M., Bethlehem-Sparrows Point Shipyard, Inc., Sparrows Point, Md.
Maihl, G. W., Consolidated Gas, Electric Light and Power Company, Baltimore, Md.
McLean, W. (Member), Consolidated Gas, Electric Light and Power Company, Baltimore, Md.
Miller, C. W., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Monius, G. F., Consolidated Gas, Electric Light and Power Company, Baltimore, Md.
Morgan, J. I., Allegheny Industrial Electrical Company, Inc., Pittsburgh, Pa.
Phillips, G., Bethlehem-Sparrows Point Shipyard, Inc., Sparrows Point, Md.
Powell, E. U., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Pumphrey, O. F., Consolidated Gas, Electric Light and Power Company, Baltimore, Md.
Ridgley, C. J., I T-E Circuit Breaker Company, Philadelphia, Pa.
Riggs, H. C., The Electric Storage Battery Company, Philadelphia, Pa.
Schwartz, H. E., Consolidated Gas, Electric Light and Power Company, Baltimore, Md.
Singer, G., National Bureau of Standards, Washington, D. C.
Stephenson, R. E., United States Engineer Office, Cincinnati, Ohio.
Thompson, R. P., Line Material Company, Zanesville, Ohio.
Watkins, W. H., Line Material Company, Zanesville, Ohio.
Wiegand, D. E., Line Material Company, Zanesville, Ohio.
Wilson, M. E., Consolidated Gas, Electric Light and Power Company, Baltimore, Md.

3. New York City

Bollinger, A. J., Jersey Central Power and Light Company, Allenhurst, N. J.
Cangemi, J. F. (Member), Air Depot Architect-Engineers, New York, N. Y.
Dieli, F. J., Ansley Radio Corporation, Long Island City, N. Y.
Duna, A. L. (Member), American Steel and Wire Company, New York, N. Y.
Edwards, L. E. (Member), Bussmann Manufacturing Company, New York, N. Y.
Ivanoff, N. A. (Associate re-election), Merritt, Chapman and Scott Corporation, New York, N. Y.
Jayne, G. E. (Associate re-election), Moore McCormack Steam Ship Company, New York, N. Y.
Ludwick, W. L. (Member), Thomas A. Edison, Inc., West Orange, N. J.
Otto, G. E. (Associate re-election), Otto Brothers, Ridgewood, N. J.
Schott, L., Bell Telephone Laboratories, Inc., New York, N. Y.
Vladikov, E. I., Gibbs and Hill, New York, N. Y.

4. Southern

Gallagher, J. A., Southern Bell Telephone and Telegraph Company, Atlanta, Ga.
Hill, J. A., Jr., Ethyl-Dow Chemical Company, Wilmington, N. C.
Matheson, I. C., Allis-Chalmers Manufacturing Company, Tampa, Fla.
Miles, J. H., Georgia Power Company, Atlanta, Ga.
Piccione, N. E., Tennessee Valley Authority, Wilson Dam, Ala.

5. Great Lakes

Braam, A. E. (Associate re-election), Northern Indiana Public Service Company, Hammond, Ind.
Calkins, R. L., Pennsylvania Salt Manufacturing Company, Wyandotte, Mich.
Campbell, W. J., Detroit Edison Company, Detroit, Mich.
Eberly, J. C. (Member), General Motors Corporation, Detroit, Mich.
Ernsberger, L. D. (Member), Olds Motor Works, Lansing, Mich.
Field, W. J., Minneapolis-Honeywell Regulator Company, Minneapolis, Minn.
Fleming, R. W., McCaffery Company, South Bend, Ind.
Hill, C. W., Jensen, Bowen and Farrell, Ann Arbor, Mich.
Jolly, F. J., Detroit Edison Company, Detroit, Mich.
Kahn, F. L. (Member), Automatic Electric Company, Chicago, Ill.
Manuszak, W. T., Bendix Aviation Corporation, South Bend, Ind.
Matthews, H. D. (Member re-election), W. M. Chace Company, Detroit, Mich.
Overton, A. G., Jr., Bendix Products Corporation, South Bend, Ind.
Pletcher, F. F., Indiana and Michigan Electric Company, Mishawaka, Ind.
Schafer, J. E., Jensen, Bowen and Farrell, Ann Arbor, Mich.
Sturtzen, C. A. (Member), Allis-Chalmers Manufacturing Company, West Allis, Wis.
Walton, O. H., Illinois Bell Telephone Company, Chicago, Ill.

6. North Central

Sensintaffar, R. M., Bureau of Reclamation, Casper Wyo.

7. South West

Breese, R. A., General Cable Corporation, Dallas, Texas.
Ellicock, A. B. (Associate re-election), James R. Kearney Corporation, St. Louis, Mo.
Field, J. H., Gulf Oil Corporation, Tulsa, Okla.
Friedsam, S. R., Lower Colorado River Authority, Austin, Texas.
Graeter, R. M. (Associate re-election), Southwestern Gas and Electric Company, Longview, Texas.
Parker, E. M. (Member), Fraser-Brace Engineering Company, Inc., Weldon Spring, Mo.
Ray, D. (Member), Nelson Electric Manufacturing Company, Tulsa, Okla.
Rhodes, W. C., Room 313, Drew Building, Tulsa, Okla.
Sanders, R. B., United States Division Engineer Office, St. Louis, Mo.
Siegel, E. M. (Member), University of Texas, Austin, Texas.
Smith, L. L., Allis Chalmers Manufacturing Company, Houston, Texas.
Taylor, E. R., Midwestern Engineering and Construction Company, Tulsa, Okla.
Thomas, J. D., James R. Kearney Corporation, St. Louis, Mo.
Want, V. D., Texas Engineering Company, Austin, Texas.

8. Pacific

Sargentich, D. M., Vega Airplane Company, Burbank, Calif.
Wallace, P. H., P. O. Box 451, Kingman, Ariz.

9. North West

Bowman, J. F., Inland Empire Rural Electrification, Inc., Spokane, Wash.
Campbell, V. P., Inland Empire Rural Electrification, Inc., Spokane, Wash.

10. Canada

Baker, B. O., Canadian General Electric Company, Peterboro, Ontario, Can.
Shill, P. W. (Member), British Columbia Electric Railway Company, Limited, Vancouver, B. C.
Smith, J. H., Canadian General Electric Company, Ltd., Toronto, Ont.
Snyder, C. E. (Member), Packard Electric Company, Limited, St. Catharines, Ont.
Sprentall, G. H., Commonwealth Electric Corporation, Limited, Welland, Ont., Can.
Wilson, R. J. G., Hydro-Electric Power Commission of Ontario, North Bay, Ont.

Total, United States and Canada, 108

Elsewhere

Abislaiman, A. L., Post Office Box 4, Habana, Cuba.
Appold, E. C., Genelectric Rayus X, S. A., Mexico, D. F.
Enriquez, O. R., National Irrigation Commission, Mexico, D. F.
Gilchrist, S., Royal Navy, Sandbank, Argyllshire, Scotland.
Golde, R. H., The British Electrical and Allied Industries Research Association, London, W. C. 2, England.
Johnston, D. L., Marconi-Ekco Instruments, Ltd., St. Albans, Herts, England.
Marin, E. R. P., National Telegraph Company, Mexico, D. F.
Tappan, M. B., Jr., General Electric, S. A., Mexico, D. F.

Total, elsewhere, 8

OF CURRENT INTEREST

Mobilizing the Nation's Inventive Brains

A description of the aims and methods of the National Inventors Council, furnished through the courtesy of Doctor W. D. Coolidge (M'34), vice-president and director of research, General Electric Company, who is chairman of the Council's committees on geometrical and optical instruments and on signals and communications.

In order that the National Inventors Council may achieve the highest possible success in eliciting from the inventive brains of the nation all suggestions applicable to national defense, it is necessary that inventors be assured that suggestions submitted to the Council are receiving adequate consideration. To convey such assurance is the purpose of this article.

The National Inventors Council, Department of Commerce, was organized in the summer of 1940 as a central clearing-house for defense suggestions. Of these, approximately 2,600 have been given more than a preliminary study, although only a comparatively small percentage have actually been adopted by the Army or the Navy.

This record compares with the following results obtained by similar agencies that functioned during the first World War or are functioning during the present emergency.

Unit	Period	Inventions Handled	Inventions of Merit	Percentage
Inventions Section, General Staff, War Department	First World War	25,000	25	0.1
Naval Consulting Board	First World War	110,000	110	0.1
Superior Inventions Committee, French Government	First World War	45,000	1,958	4.3
Directorate of Scientific Research of Great Britain	Sept. 1939–Aug. 1, 1941	50,000	125	0.25

It will no doubt be very surprising to some that the percentage of inventions of merit is so low. At least there is some satisfaction in the fact that this percentage is higher both in Great Britain and in the United States during the present war period than during World War I.

INVENTIONS VERSUS RESEARCH

There is a fairly clear line of demarcation between inventions and research and development. This has been recognized by the Federal Government's creation of two separate agencies. The National Inventors Council confines its attention to inventions that are presumably ready for trial or for use. On the other hand, the Office of Scientific Development and Research and its subsidiary body, the National Defense Research Committee, specialize on the solution of research problems of a defense character. The National Inventors Council is a small organization without funds for development purposes. The National Defense Research Committee has development funds and extends its operations throughout a very large section of the research facilities of the United States. As Doctor James B. Conant, chairman of the National Defense Research Committee, has recently pointed out, more than 1,000 scientists and over 3,000 persons are now working on problems under investigation by the committee. Approximately 50 per cent of the "starred" chemists (those starred in "American Men of Science") and 75 per cent of the starred physicists of the country are giving part or all of their time to these questions. This work involves 270 contracts with 47 different universities, and 153 contracts with 39 industrial firms.

There is a very close working relationship between these two agencies. If the National Defense Research Committee receives an invention (other than a solution of one of the problems under study), it is referred to the National Inventors Council for examination and disposition. In turn, if the National Inventors Council finds that a given invention needs further development before it is ready for use by the Army or Navy, the question is raised as to whether the National Defense Research Committee would be interested in setting up a project for its development.

MILITARY VERSUS INDUSTRIAL INVENTIONS

The National Inventors Council endeavors to restrict its activities to the examination of "defense" suggestions; that is, inventions that pertain to weapons of war or other articles that are of primary interest to the Army and Navy. It has been found difficult to establish any clear-cut definition of a "defense" suggestion. As Colonel Leonard B. Ayres reported after the first World War in his summary "The War With Germany," the Army purchased about 30,000 kinds of commercial articles. He stated, "Purchases included food, forage, hardware, coal, furniture, wagons, motor trucks, lumber, locomotives, cars, machinery, medical instruments, hand tools, machine tools. In one way or another the Army at war drew upon almost every one of the 344 industries recognized by the United States Census. In some cases readjustments of machinery for a slightly modified product were necessary. In many an improved product was required."

Since that time, the Army and Navy have greatly expanded their wants and necessities. The arsenals and navy yards are as much interested as is a private industrial plant in new types of machine tools or in new welding or riveting processes. The Quartermaster Corps purchases practically everything that is sold for human consumption. Therefore, the Council has found that certain inventions of a seemingly commercial nature are of interest to the armed services. Nevertheless, a real effort is made to give primary consideration to products or processes that are especially designed for military use. If a submitted invention seems to have purely industrial application, it may be offered to the Office of Production Management, but ordinarily it is suggested to the inventor that he seek to secure its commercial acceptance.

COUNCIL ORGANIZATION

The National Inventors Council was created by action of the Secretary of Commerce in concurrence with the President and is an integral part of the Department of Commerce. Its membership, representative of inventors, scientists, industrial leaders, and public officials, all of whom serve without compensation, is as follows:

C. F. Kettering, president, General Motors Research Corporation, Detroit, Mich., *chairman*

Thomas Midgley, Jr., president, Ethyl Gasoline Corporation, Worthington, Ohio, *vice-chairman*

Lawrence Langner, 120 East 41st Street, New York, N. Y., *secretary*

George Baekeland, vice-president, Bakelite Corporation, New York, N. Y.

Rear-Admiral H. G. Bowen, United States Navy, Federal Ship Building Company, Kearny, N. J.

Honorable Conway P. Coe, Commissioner of Patents, Washington, D. C.

William D. Coolidge (M'34), vice-president and director of research, General Electric Company, Schenectady, N. Y.

Watson Davis, Science Service, 1719 N Street N. W., Washington, D. C.

F. M. Feiker (M'34), dean, school of engineering, George Washington University, Washington, D. C.

Webster N. Jones, director, college of engineering, Carnegie Institute of Technology, Pittsburgh, Pa.

Brigadier-General Earl McFarland, War Department, Room 4358, Social Security Bldg., Washington, D. C.

Fin Sparre, director, development department, DuPont Corporation, Wilmington, Del.

Major General W. H. Tschappat, United States Army (retired), Washington, D. C.

Orville Wright, director, Wright Aeronautical Laboratories, Dayton, Ohio.

Fred Zeder, chairman of the board, Chrysler Corporation, Detroit, Mich.

For working purposes, the Council is

divided into 12 committees. These committees and their chairmen are:

1. Ordnance and firearms, General W. H. Tschappat
2. Land transportation and armored vehicles, Fred Zeder
3. Aircraft and aeronautics, George Lewis
4. Remote-control devices, Chas. F. Kettering
5. Geometrical and optical instruments, Wm. D. Coolidge
6. Naval warfare, Geo. W. Codrington
7. Signals and communications, Wm. D. Coolidge
8. Chemicals and chemical warfare, Fin Sparre
9. Mechanical power plants and internal combustion engines, Chas. F. Kettering
10. Metals and metallurgy, Webster N. Jones
11. Building structures, fortifications, and camouflage, Frederick M. Feiker
12. Clothing, sanitation, health, and commissariat, Watson Davis

The sizes of the committees vary widely. In some cases the work is handled almost entirely by its chairman. In other cases, the committee includes a dozen or more experts, chosen by the committee chairman.

The staff of the Council, the headquarters of which are in Room 7424, Commerce Building, Washington, D. C., consists of approximately 30 persons, of whom 7 are engineers trained in different fields such as ordnance, aircraft, chemistry, electricity.

The staff and the committees of the Council have established close relationships with a number of co-operating agencies. Foremost among these, of course, are the Army, Navy, and National Defense Research Committee. Other Government agencies having liaison officers with the Council are the Bureau of Standards, the Office of Production Management, the Bureau of Mines, the National Advisory Committee for Aeronautics, the Office of Price Administration, the National Resources Planning Board.

The system of liaison officers with the Army and Navy works out in an extremely satisfactory fashion. In the case of the Ordnance Department, for example, three ordnance officers of the inventions section devote the major part of their time to consideration of inventions. There is daily, almost hourly, interchange of information between the staff of the Council and these officers. Inventions that are considered meritorious by the engineering staff and by the chairman of the ordnance committee are referred immediately to this inventions section. There they receive sympathetic consideration and are discussed with the appropriate expert or experts, after which an early and complete report is sent back to the Council.

This same system is in operation in other branches of the Army and Navy. At the receiving end in the Signal Corps, the Air Corps, Coast Artillery, Chemical Warfare Service, the Bureau of Ships, the Bureau of Aeronautics, and other branches, are specialized officers or groups of officers whose job is to give full consideration to each invention submitted.

SOURCES OF INVENTIONS

Inventions are received from every conceivable source. The largest volume pours in from the general public and from industrial companies which have perfected new products or processes. Any received by the War Department are promptly referred to the Council under the terms of War Department Circular No. 101, published September 12, 1940, which specifies that all inventions received from the public should be referred to the Council. Similarly, most of the inventions sent to the Navy Department are referred to the Council for preliminary examination. Members of Congress, the White House, the Office of Production Management, and other executive agencies add their quota to the flow.

Hundreds of inventions are received from foreign countries. Some come through the military or naval attachés, some direct from the inventors. Many interesting ideas have been submitted by European refugees now in the United States.

A special effort has been made by the Council to obtain the co-operation of the most productive inventors in the United States. Some of these operate as individuals, but many are attached to the staff of industrial companies or research laboratories. The best inventions usually are presented by well-trained minds which have devoted years of study to certain fields of invention. As time goes on a larger percentage of the material reaching the Council comes from persons of this kind who feel that they have a real contribution to render to the defense program.

FORM OF SUBMISSION OF INVENTIONS

Inventions are submitted to the Council in every gradation of detail. Many are simply in idea form—a brief letter offering a generalized solution to a given problem, such as night bombing, without attempting to work out the details. Others are presented in the form of patents granted or in applications for patents. In many instances the submission is by complete disclosure, somewhat similar in character to a patent application except that it is expressed in less legalistic fashion.

The Council has urged that all submissions be in writing. This is partly for the protection of the inventor, but primarily because each invention must be examined by a number of experts, and it is impossible to arrange interviews with all of them. However, no interviews are denied by the staff of the Council; and such interviews frequently serve to good advantage in suggesting a modification of the invention to serve a specific military need.

Models are frequently received, but are not solicited, as it is believed that a written description ordinarily is sufficient to disclose the purpose of the invention. Models that are received are photographed and returned to the owner.

TYPES OF INVENTIONS

Approximately 40 per cent of the inventions received by the Council is in the general field of ordnance, including machine guns, ammunition, artillery, tanks, gun carriages, amphibians, antiaircraft guns, and rifles. The other 60 per cent is divided fairly equally between the remaining 11 committees of the Council, with the larger percentage going to aircraft and aircraft defense, naval vessels and naval warfare, and internal-combustion engines. A relatively large number pertains to geometric and optical instruments and to electrical and radio devices. These fields are expanding ones, and a great deal of original work is being done, not only by the large companies, but by many independent workers. Some of the most interesting inventions received in these fields have come from independent workers.

HOW INVENTIONS ARE HANDLED

Ordinarily, inventions received by mail are recorded and acknowledged, and the papers passed to the engineering staff for preliminary examination. If this shows that the invention offers something new and of value to the military services, the material is submitted to the chairman of the appropriate committee, who makes a written report and recommendation. The most usual recommendation is either for rejection or for submission to the armed services. In the latter case, the staff forwards the invention to the proper liaison officer, who later files a written report recommending rejection or notifies the Council that the invention will be given further consideration by direct dealings with the inventor.

After examination is complete, the inventor is notified as to the result. The papers are then filed, but are not considered dead as it has been found necessary to review periodically almost every category of invention. This reconsideration is done by the staff, by the liaison officers, or by special committees or agencies that are set up to consider certain problems.

In view of this periodic reconsideration, the Council wishes to retain disclosures of all inventions, and for this reason an inventor should retain a complete copy of the material submitted.

PRINCIPAL DIFFICULTIES

The Council is giving attention to the length of time for examination of inventions. Every effort is made to eliminate unnecessary delays, but it takes time for full consideration by the engineering staff, the Council committees, and the interested armed services.

Some inventions are on the border line between an entirely new idea and one that is ready for commercial exploitation. If it is actually in production and fills a military need, it may be accepted by the Army or Navy within a few days or a few weeks. Most inventions, however, involve a long study of their merits as distinguished from other known methods of accomplishing the same purpose. Consideration must also be given to the available productive capacity. An otherwise meritorious article may be rejected for immediate use on this ground alone.

In any event, the Council is trying to speed up its operations so the inventor may be advised within a reasonable length of

time as to whether or not there is any military value to his suggestion. The Council has no part in the final negotinations between the armed services and the inventor as to contracts, patents, royalties, or rights.

The most important problem faced by the Council is that of making sure that all of the inventive genius of the United States is marshalled to the needs of the war program. It is a truism that "Wars are won by invention." Inventions played an important part in the War of 1812, when Eli Whitney developed a method of mass production of muskets. The successful defense of the Monitor against the Merrimac marked a real turning point in the Civil War. The submarine, the tank, and the airplane are modern war weapons developed by American ingenuity.

The present world conflict is mechanized warfare on a scale undreamed of even 20 years ago. The result will depend in large measure upon further improvement of existing weapons and the development of new weapons. The United States has, above all countries, the resources, the education, and the ability to produce new electrical, mechanical, and chemical devices.

The Council feels a share of responsibility in the encouragement of such development. It is, of course, true that specific problems are being handled by the National Defense Research Committee and by various branches of the Army and Navy. Over and above this, there is a need for bringing into being inventions that are radical and epoch-making in character. Many of these spring from individuals, sometimes obscure individuals, who have consecrated their life work to such ends. The Council wishes to maintain an open door to all such individuals and to all other sources of invention. It wishes to make known to all persons in the United States and to all defenders of Democracy everywhere that a sympathetic hearing will be given to any inventor, no matter how radical his idea.

NAM Congress of American Industry Devoted Largely to Defense Topics

The future of America and the impact of defense upon civilian industry featured the five-day Congress of American Industry held in New York, N. Y., December 1–5, 1941, by the National Association of Manufacturers. Army, Navy, and defense officials, and American industrial leaders discussed various phases of these subjects.

At the close of the Congress, the Association adopted its platform for 1942 in which it said: "American industry realizes the task that faces it. It will willingly make what sacrifices are necessary. It will produce machines and equipment needed to defend our freedom. It will do the job with a speed and efficiency that will astonish the world. American industry is proud of its ability to meet the present challenge. It will show that the spirit of freedom is the strongest power on earth; that no amount of slave labor can equal the voluntary co-operation of free men."

Brief abstracts of three of the prepared addresses are presented here: "Future Demands of Our Defense Program on American Industry," by Donald M. Nelson, executive director, Supply Priorities and Allocations Board, Washington, D. C.; "The Nature and Future of Private Enterprise," by Edwin G. Nourse, director, Institute of Economics, The Brookings Institution, Washington, D. C.; "Industry's Place in a New World," by K. T. Keller, president, Chrysler Corporation, New York, N. Y.

FUTURE DEMANDS OF DEFENSE PROGRAM ON INDUSTRY

Prefacing his remarks with the statement that he had always been a business man and that he was talking as a friend rather than as a critical outsider, Donald M. Nelson in his address said that "business and industry in this country—particularly big business and big industry—need to do more rather than less than they have been doing to adjust themselves to this program and to fill the responsibilities which the program brings them. . . . The big outstanding fact before us today is that our defense production effort, huge as it is, is not big enough. . . . I believe that, at the very least, production volume must be doubled. . . .

"Obviously, if we undertake to double current armament production . . . and set ourselves to turn out military goods at a rate of better than 40 billion dollars a year, the future demands on American industry are going to be ever so much greater than they have been so far. It is equally obvious that as the demands increase, so also does the responsibility. The government can't do this job alone. It can chart the program, set the sights, put up the money and co-ordinate the various efforts, but the actual job of getting the goods out must be done by industry itself."

Concerning shortages of materials resulting from the defense program, Mr. Nelson offered some concrete suggestions to industry. He urged individual producers who no longer can get the materials needed to manufacture their products to endeavor to obtain contracts for defense products. An alternative is to look for substitute materials or alternative processes. "In the very nature of things," he said, "the difficulties caused by shortage of materials bear more heavily on the small manufacturer than on the large one. . . . I believe that in our present emergency it is up to the big fellow to help the little fellow. There are a good many ways in which he can do that. The most obvious, of course, is through subcontracting. . . . And that is not all of the story, either. I can think of no good reason why our large manufacturers should not actively aid our smaller producers on this whole problem. . . . There are engineering and research skills and services which can be made available. There are, I believe, extensive possibilities in the way of the sharing of knowledge, assistance in the matter of pooling resources, guidance and help in the bringing together of separate productive resources."

Speaking of the equal responsibilities resting upon industry and upon labor, Mr. Nelson said: "More than anything else today, we need a unity of industry and labor in this emergency. I don't mean an impossible sort of unity, in which no employer ever says 'no' to a labor spokesman and no union ever dreams of talking about a strike. I mean the kind of unity which comes to strong, self-respecting, and independent groups which realize to the full the fact that they are on the same side, working in a common cause. I mean the kind of unity which comes when the members of each group know that while they may have disagreements and differences with the members of the other group, the members of that other group are, like themselves, making an honest and sincere effort to put their country's need above their own in a time of crisis."

THE NATURE AND FUTURE OF PRIVATE ENTERPRISE

In his address on this subject, Edwin G. Nourse first traced the history of the growth and achievements of private enterprise. "It would be easy to elaborate these self-evident achievements and constructive possibilities of modern private enterprise into a rosy picture of the future of what we are pleased to call the American Way of business life." He then raised the question as to whether business men really believe in private enterprise. In discussing this question, Doctor Nourse said that: "It has become increasingly apparent in recent years that the practical wisdom of businessmen does not confirm my economists' analysis of the great capacities and promise of the private enterprise system. . . . I find widespread a sort of bitter resignation to the early passing of this system. A few . . . talk with confidence of the ability of private enterprise not only to survive but to go forward to new triumphs after the war. . . .

"There is no going 'back to normalcy' as Warren Harding fondly dreamed," he continued. "The only way for private enterprise to vindicate itself is by marching forward to economic practices and policies as new in their way as television, synthetic plastics, and automobiles without a gearshift. But efficiency of design does not mean that these new structures and practices shall become centralized, rigidified, recast in the mold of 'the provident state.' The farther I press scientific lines of economic analysis, the more am I convinced that economic efficiency demands more, not less, freedom of private enterprise."

Doctor Nourse said that the crucial test of private enterprise may come within as short a time as two years. When armistice replaces actual war conditions, release of the selectees and displacement of labor in munition industries will cause great dis-

locations, he said. Plant capacity will be greatly expanded and no one will know the trend of taxation or the terms of peace treaties. Also unknown will be the extent to which Europe can recover within a given time, he added, or the extent, if any, of governmentally blocked trade relations.

"No one who reads the signs and omens in the economic world today can fail to realize that the future of private enterprise hangs in the balance," he said. "Among our fellow citizens, there is a substantial fraction of persons of influence and sometimes in authority who are profoundly convinced that the system is 'all washed up.' They are busy planning the steps by which it is to be displaced. They are confident in their faith in a new system, indefatigable in their labors to promote it, contemptuous of the failures of the present system, debonair in their willingness to assume the responsibilities of running a new order."

INDUSTRY'S PLACE IN A NEW WORLD

"Today's crisis in world relations is a challenge to our productive ability," said K. T. Keller in his address on this subject. "The output of American industry will determine for many years to come the way of life of millions of people on every continent of the globe."

Speaking of our defense production, Mr. Keller said: "In a little more than a year, we, under a free competitive enterprise system, have reached a production stage that it took German industry, under a dictatorship, from three to five years to reach. The job is still a long way from satisfactory production but we are on the way to the greatest production ever known or dreamed of in this world. . . . Starting from scratch a year and a half ago, the United States armament program has passed 65 billion dollars in authorized expenditures and, according to reports from Washington, it is soon to be greatly augmented—maybe even doubled. It started with 5 billion. So in less than 18 months, the defense load to be undertaken by American industry has multiplied 15 times. According to present prospects, American industry will be expected to produce 30 billion dollars in actual defense output during 1942. In 1939, American manufacturers produced 38 billion dollars worth of manufactured products. Thus, the industries of America will produce next year armaments and related defense items at a rate equal to three fourths of their total normal annual output of peace-time goods. . . .

"The astonishing thing today is not that America has this great asset of productive ability and that the industrial genius of the country is the brawn and sinew and the heart and brains of defense production. The astonishing thing is that the American people are only beginning to realize it. They are beginning to realize that it is to American industry they look to supply the defense of their country. And as they come to that realization, they will have greater respect for industry.

"Called upon in the previous world war, industry turned to and produced. In the reconstruction that followed, industry led the way to recovery. Now it has come through the depression and once more another world war faces us and another cycle starts."

Voicing a plea for "all-out" co-operation in industry's great effort, Mr. Keller said: "There is nothing insurmountable in the tasks confronting us. But how much easier they would be, how much greater and quicker the results, if they could be done with a spirit of enthusiasm, understanding, and co-operation among all those involved...

"There is nothing lacking in the ability of industry to do the jobs that must be done. There is nothing lacking in the will of the industry to do even what looks like the impossible. There is nothing lacking in co-operation on the part of the Army and Navy. If anything is lacking, it is a realization of the tremendous problems of adjustment involved in transferring industry from civilian to defense work in so large volume. It is my simple belief that this can best be accomplished by a pat on the back and by a friendly hand. To do this job right, every American must feel that he has a part in it, no matter what that part may be.

"As people become increasingly aware," he continued, "of what industry is doing today for defense; as they realize more and more what industry has already done for the fuller life of everyone; and as industry takes on its post-war responsibilities, these people will also make sure that the soil in which industry grows and brings forth its fruit will not be sown with cockle.

"Industry does not like war; industry thrives only in time of peace. War is not a natural state of free Americans. War is not the state in which industry performs its best services.

"So while putting its shoulder willingly, ably, and effectively to the wheels of defense, industry sees its future in peace-time pursuits. Given the opportunity to exercise its initiative, its courage and its resourcefulness, the potentials of industry's service to the future are unbounded and presently not even imagined."

NAM Reports on Electric Power

Among the various reports presented at the Congress of American Industry held December 1–5, 1941, in New York, N. Y., was one on electric power, prepared by the Association's research department. While conceding vastly increased needs for electric power, the report warns that unwarranted building of power facilities is likely to create excess capacity which will become burdensome in the post-war period. Measuring the electric-power industry against the demands of the defense program, the report found that:

1. For the country as a whole the power supply plus new construction scheduled for completion before 1944 should prove sufficient to meet probable demands of the defense program.

2. In the southeastern states, where there has been a serious drought, and in a few other areas there will be power shortages, but many of these shortages are being corrected by new installations.

3. The St. Lawrence Seaway project does not provide a practical solution to the power problem because it will require men, money, and materials more urgently needed elsewhere.

4. Electric-power equipment owned and operated by industrial plants may prove unequal to the increased demands of the defense program, and utility companies should make due allowance for this contingency in estimating future power demands.

5. There is a need for a moderate amount of interconnection of transmission lines to close some of the gaps in high-voltage transmission systems.

6. Two factors beyond the control of the industry—limited facilities for the manufacturing of heavy electrical equipment, and limited facilities for the transportation of fuel—may have an important bearing on the future power supply.

"At the start of its defense effort the United States was fortunate to have an electric-power industry exceeding the maximum capacity of England, France, Germany, and Italy," the report said. "This industry, built very largely through private enterprise, has made electricity part of our daily lives and a necessity in almost every kind of business."

The Association found that 70 per cent of the nation's power was generated from steam power, and that private and public hydroelectric projects produced 28 per cent; two per cent is produced by internal-combustion engines.

"From these facilities, excluding factory owned power plants," the report said, "were produced a total of 144,984,565,000 kilowatt-hours of electric energy in 1940, more than three times the output for 1920. These represented an average use of about 40 per cent of power-generating facilities."

The report pointed out that peak load periods are never constant, nor do they occur simultaneously throughout the country. But, it said, the utility industry must be prepared to anticipate these peak power loads and must measure the adequacy of its facilities in relation to them. In producing the record total of power generated in 1940, the survey said, the sum of peak demands for all power systems was 76 per cent of installed capacity.

"To meet the demands of the national defense program," the report continued, "the private electric light and power companies will spend more than $1,000,000,000 on installations of new facilities of all kinds during 1941 and 1942, the largest expenditure since 1930 and 1929. The schedule provides for 2,126,400 kw to be added in 1941, 2,344,000 in 1942, and 2,292,000 in 1943. Public power projects are scheduled to add 1,344,100 kw in 1941 and nearly 2,348,500 in 1942 and 1943. To this total must be added about 900,000 kw for power plants of factories."

It is difficult to estimate what the effects of the defense program will be in terms of increased power demands, the report said. The Federal Power Commission has reached certain estimates of probable peak loads for the 12 months through June 1942, for individual areas. The Commission's estimates are in practically all cases higher than those of the private utilities. The Association said that not sufficient importance was given to four factors that may restrict power consumption during the national emergency:

1. Probable reductions in the ranks of industrial

manpower due to military service and shortage of skilled workers.

2. Curtailment of production of civilian goods due to rationing of supplies.

3. Some of the power demand originating at the opening of the defense program may lessen due to decreased consumer demand for goods.

4. As the defense program advances more factories will work more shifts per day without a commensurate rise in peak demand.

The report also discussed the power shortages that have developed in some areas, and called attention to the fact that the construction of government power projects has made it extremely difficult for private utilities in adjoining territories to spend money for future power needs.

Advocates of the St. Lawrence Seaway as a means of creating electric power have accepted the reports of the Federal Power Commission about a shortage in up-state New York, the report said. These shortages, according to the FPC, are due to the concentration of the aluminum industry at Massena and the industrial development around Niagara Falls. The aluminum industry at Massena is furnished its power from the Beauharnois hydroelectric development in Quebec, Canada, an installation that was made primarily to supply energy to industrial plants.

Proponents of the St. Lawrence Seaway development, said the report, "have based their arguments on an overestimate of power needs and a gross overstatement of probable power markets in the future. They are also giving too little consideration to the time element. It is true that industries thriving on cheap hydroelectric power have a way of migrating to regions where there are developments of this kind. At some time in the distant future the power phase of the project might be justified economically. The New York Power Authority in its estimates of future power sales appears to have been guilty of statistical exaggeration. The forecast of power sales in 1950 by the New York Power Authority is obviously out of line with the trend of power sales in New York State. It was reached by assuming a continuation of a constant rate of growth based on the two periods of most rapid expansion beginning in 1924 and in 1934."

Government Survey Urged for New York Power Line

In order to expedite construction of an electric-power transmission line from New York City to Massena, N. Y., to serve the new aluminum plant being built at Massena, Director General William S. Knudsen of the Office of Production Management has recommended that surveys be initiated immediately by the United States Corps of Engineers. In his letter of November 28 to the Under Secretary of War, Mr. Knudsen said that the OPM had not yet completed the study necessary as a basis for a final conclusion as to the best plan for transmitting surplus New York City power to Massena. "However," Mr. Knudsen continued, "it is apparent that any plan will require the construction of a Government-owned transmission line from Taylorville to Massena. And if our study, when finished, shows that the entire line should be Government-constructed, as the most feasible plan in the interest of national defense, then it would be necessary to construct the New York City-Taylorville section."

Southeast Power Curtailment Indefinitely Postponed

Following an all-day meeting in Atlanta, Ga., with representatives of the major public and private utility systems in the Southeast, the power-branch staff of the Office of Production Management announced November 26 indefinite postponement of the pending 30 per cent power curtailment of large commercial and industrial consumers in six Southeastern states, and the definite assurance of relaxation of black-out restrictions.

The following provisions of the OPM power-limitation order, however, the announcement stated, must be continued in full force and effect:

1. Freezing of consumption at September 1941 levels of large commercial and industrial consumers in Georgia, Alabama, Tennessee, eastern Mississippi, southeast South Carolina, and northwest Florida.

2. Power-pooling arrangements for maximum deliveries of power into the shortage area.

3. Strict compliance with black-out restrictions until the restrictions are lifted.

Positions to Be Filled Through Civil Service Examination

Notice of the following positions, which will be filled through civil service examinations, is published here as a service to members of the Institute. Application forms and full information as to requirements for examinations may be obtained from the secretary of the Board of United States Civil Service Examiners at any first- or second-class post office, or from the United States Civil Service Commission, Washington, D. C.

Air Corps Investigators. Investigators maintained by the Materiel Division of the Air Corps to protect military information and air corps projects. These positions pay from $3,200 to $4,600 a year. No written test will be given, but applicants will be rated on their education and experience. Experience in appropriate investigative work is required. This may have been gained in the investigation of criminal activities for a governmental agency or for a private agency whose operations were nation-wide in scope. Experience in the investigation of cases of property destruction by violence for a railroad or other industrial or commercial concern may also be accepted. For the two higher positions ($3,800 and $4,600 a year) a part of the experience must have been in administrative or supervisory positions which involved the planning of work for a group of employees assigned to investigative duties. Provision is made for the substitution of appropriate college or law school study for a part of the nonsupervisory experience prescribed.

Physicist, Explosives Chemist, and Chemical Engineer. Examinations reannounced, with modified requirements. Salaries ranging from $2,600 to $5,600 a year. For all, appropriate college study and experience are required. In physics, there is great demand for physicists well qualified in stress analysis, ballistics, elasticity, vibration studies, vacuum-tube circuits, and short radio waves. Provision is made in the new announcement for accepting applications for the assistant grade positions ($2,600 a year) from applicants who wish to qualify on college teaching unaccompanied by research. In chemical engineering there is a shortage of qualified people in plant layout, equipment design, market analysis, chemical economics, heavy chemicals, plastics, rubber, agricultural by-products, and strategic minerals. Applicants may now substitute college teaching in chemical engineering or chemistry for part of the prescribed experience. In the new physicist and chemical engineer examinations, the recency requirements relative to experience have been modified. Over 100 explosives chemists are needed. In this examination the term "explosives chemistry" is interpreted to mean "research, developmental or production work on explosives, or materials which require for their preparation and handling, methods, techniques, and precautionary measures similar to those used for explosives". There is no longer a "recency" clause in the announcement. For all of these examinations the age limit has been raised to 60 years, for regular probational appointment. Provision is also made for the waiver of age and physical requirements for temporary positions connected with the defense program.

National Defense Book Campaign. A campaign to collect "millions of books" for United Service Organization houses, Army "dayrooms," ships, Naval bases, etc., will be launched January 12 under the joint auspices of The American Library Association, the American Red Cross, and United Service Organizations. According to an advance announcement, the books should be taken to libraries, where they will be sorted, repaired if necessary, and sent on as quickly as possible to the spots where men in the service want them. Men in the services have a wide range of reading interest, and they are particularly eager for up-to-date technical material to help with their problems, as well as books on current affairs and plenty of good fiction.

JOINT ACTIVITIES

Defense Principal Topic at ASA Annual Meeting

"Standardization is going forward in this country at a rate never reached before," said R. E. Zimmerman, president of the American Standards Association at its annual luncheon meeting December 10, 1941, in New York, N. Y. Some 300 representatives of trade, technical, and governmental groups who hold membership in the American Standards Association met to hear addresses by Mr. Zimmerman, J. Lessing Rosenwald, head of the new Bureau of Industrial Conservation of the Office of Production Management, and R. P. Anderson, chairman of the Standards Council of the American Standards Association.

All three speakers dwelt on the part that the ASA is playing and can play in the country's defense program. "This entire defense effort," said Mr. Zimmerman, "has been seriously hampered by the diversity of specifications and requirements for products—acutely so in the case of strategic materials.

"What a boon it would have been to the industries of this country if at the beginning of the defense effort we had had 5,000 good, seasoned American Standards instead of 500! Many a manufacturer who is today facing a shut-down as a result of the defense

program through lack of scarce materials would have been able to carry his full part in production had we had a full complement of American Standards to which our manufacturers, big and little, were accustomed to working."

Commenting upon some of the work specifically dealing with defense needs, Doctor Anderson said: "Last January, the Association seeing that it would be called upon for special services, adopted a short-cut emergency method of developing standards needed for defense. This action was related to that of the British and Australian associations, both of which have been issuing defense emergency standards under a similar procedure. Four such standards have already been developed.

"Still along the lines of defense, the American Standards Association has been requested by the Office of Price Administration to undertake four projects, three of them for commonly used household appliances like refrigerators. The purpose of these particular jobs is to assure the public of the quality of these products in the face of shrinking supplies of raw materials and to conserve production space needed for war orders.

"A proposal has just been made for standards for flood-lighting of defense plants in order to reduce risk of fire and theft, and to make night work possible as well as safer.

"I believe that one of the most important jobs, perhaps *the* most important job for the Association during the coming year lies in its program of Defense Emergency Standards.

"The war has, of course, disrupted international co-operation in standardization work," Mr. Zimmerman continued. "It has, however, greatly stimulated interest in inter-American co-operation in standardization work. Such co-operation offers an effective means of improving trade relations from which both the Latin American countries and the United States would benefit.

"A special committee of the Association appointed to consider the whole question of inter-American co-operation recommends a broad program which would include: the exchange of information and material with all Latin American organizations doing significant standardization work, arrangements for translation of standards into Spanish and Portuguese, and intimate co-operation with each country in the development of its standards.

"Senor Ceriale, director of the national standardizing body of Argentina, has accepted an invitation to visit the United States as a guest of the American Standards Association. This visit, which is to take place in the early part of the year, will give Senor Ceriale a chance to study at first hand the development of American industrial practices and standards. Arrangements will be made for him to visit the major manufacturing centers of the country."

Summarizing the work accomplished by the Association in the past 12 months Doctor Anderson said: "This year we have approved 130 standards plus 4 emergency standards developed under the short-cut procedure approved by the Standards Council last January for handling defense work. Of the 130 standards approved, 69 were new and 61 revisions of previously completed jobs. The total output of standards this year is double that of any year in our history.

"Last year 4 new standardization projects were undertaken. This year we have started no less than 15. This means that we have more than tripled the number of new projects to be undertaken as well as quadrupling the output of new standards.

"This year has seen approval and publication of the first standard in the new building-code program. It has also seen approval of the first standards in the field of photography. Included among the more than a hundred standards completed are a number for gas appliances, several in the toxic dusts and gases field, a record number in the mechanical field, specifications for pigments, tests for petroleum products, and the first of a series of standards on sizing children's clothing. This record shows how the work of the Association is reaching out into new fields.

ASA officers for 1941–42 also were elected at the meeting. R. E. Zimmerman, vice-president of the United States Steel Corporation, was re-elected president. H. B. Bryans (M'17, F'18) executive vice-president and director of the Philadelphia Electric Company was elected vice-president of the Association. H. S. Osborne (A'10, F'21) engineer in charge of operating results of the American Telephone and Telegraph Company and AIEE representative on the Standards Council, was elected chairman of the Council, and A. W. Whitney, National Conservation Bureau, vice-chairman, succeeding Doctor Osborne.

United Engineering Trustees, Inc. Elects Officers, Issues Report

United Engineering Trustees, Inc., held its annual meeting October 23, 1941, at which time officers for the year 1941–42 were elected. Albert Roberts was elected president; F. M. Farmer (A'02, F'13) was elected vice-president and J. P. H. Perry was re-elected vice-president. Arthur S. Tuttle was elected treasurer, W. D. B. Motter, Jr., re-elected assistant treasurer, and John H. R. Arms re-elected secretary and general manager. The executive committee consists of the president, the two vice-presidents, Harry A. Lardner (A'94, F'13) past president, and Walter Kidde, past treasurer.

Members of the board of trustees of UET for 1941–42 are:

Terms expiring October 1942

J. H. P. Perry, ASCE
H. A. Lardner (A'94, F'13) ASME

Terms expiring October 1943

A. S. Tuttle, ASCE
Albert Roberts, AIME
Walter Kidde, ASME
C. E. Stephens (M'22) AIEE

Terms expiring October 1944

C. E. Trout, ASCE
W. D. B. Motter, Jr., AIME
K. H. Condit, ASME
E. S. Lee (A'20, F'30) AIEE

Terms expiring October 1945

A. L. J. Queneau, AIME
F. M. Farmer (A'02, F'13) AIEE

Members of the finance committee are:

Walter Kidde, *chairman*
A. L. J. Queneau
H. A. Lardner (A'94, F'13)
C. E. Stephens (M'22)

Members of the real-estate committee are:

J. P. H. Perry, *chairman*
C. E. Trout
K. H. Condit
E. S. Lee (A'20, F'30)

President Roberts is a member ex officio of both committees.

United Engineering Trustees, Inc., was organized in 1904 to manage property and funds held jointly by the four national Founder Societies of civil, mining and metallurgical, mechanical, and electrical engineers. It maintains two departments, the Engineering Societies Library and The Engineering Foundation, reports of which appear elsewhere in this issue. The corporation (UET, Inc.) manages the Engineering Societies Building and all trust funds placed with UET, Inc.

ANNUAL REPORT

The annual report of UET, Inc., for the year ending September 30, 1941, has been submitted to the AIEE and other participating societies by H. A. Lardner, president.

Any record of business in the past year, the 37th year of the corporation, should refer to contemporary conditions which affected it. The second World War has made all conscious of scarcity of materials and of rising prices. Governmental control has increased. Markets have been uncertain. Management has risen to the new conditions and the UET has been conscious of immediate improvement in business, at the same time planning a future based on more normal conditions. The demand for technically trained men in normal and defense industry, and those called to Army and Navy service, has been felt by all our societies.

Record must be made with deep regret of the death on April 15 of an esteemed trustee, Otis Ellis Hovey, director and member of The Engineering Foundation and formerly on the Library Board, for many years treasurer of the American Society of Civil Engineers, and active in engineering interests and committee work. Former trustees widely known for their important works who died during the year were Lincoln Bush, Lewis Butler Stillwell (A'92, F'12) Arthur W. Berresford (A'94, F'14) and Bancroft Gherardi (A'95, F'12).

A review of the financial transactions during the past year shows a constant scrutiny of the portfolio by the finance committee, with helpful information and guidance by the financial counsel and the investment adviser. Replacement of certain securities improved the position of the portfolio and in some cases increased the return, maintaining the policy of safeguarding the principal while obtaining the most income possible for the conduct of Engineering Societies Library and the research work of the Engineering Foundation. All securities now are in the custody

of the Chemical Bank and Trust Company, customers' securities department.

The depreciation and renewal fund for Engineering Societies Building on September 30, 1941 totaling $452,322.15, received its usual accretion of $20,000 and interest on its investments. During the summer months renewals were necessary which were properly financed from this fund. The total book value of funds and property administered by UET, Inc., was $3,734,781.70.

The corporation is treasurer for the Engineers Council for Professional Development, and custodian of funds for Engineering Societies Personnel Service, Inc., Relief Fund, and of the John Fritz Medal Board of Award and the Daniel Guggenheim Medal Board of Award, also of contributions for specific researches by the Engineering Foundation.

A year ago a detailed report on Engineering Societies Building was made by firms of architects and real estate consultants. Many of their suggestions were necessarily rejected from immediate consideration but others were carried out for the convenience and comfort of the occupants. During the year the building has been changed from direct to alternating current and illumination in Engineering Societies Library has been improved by the use of modern fluorescent lights. Some of the Societies have taken advantage of this new light. On several floors changes have been made in elevator doors to expedite traffic. Changes have been made on one floor to provide a greater number of offices. Structural and equipment repairs were made and safety and fire insurance inspections indicate that the building is in excellent physical condition. It is adequately covered by fire, liability, and compensation insurance. The property is tax exempt. All space in the building is occupied for the purposes for which intended, by Founder Societies and associates. Co-operation with governmental agencies by providing assembly space for military and educational meetings has been provided as usual.

Reference was made last year to the clause in the charter which requires the use "perpetually" as a meeting place and headquarters, of any building erected by the corporation. The binding language prevents acquiring new property or rebuilding on the old. With no immediate prospect for any action, but in order to be prepared to take advantage of any future opportunity, approval has been received from the four Founder Societies to apply for an addition to the charter which would permit the acquisition of a new location, should this become desirable. This application will be presented to the next legislature.

On December 2, 1940, at a special meeting in conjunction with The American Society of Mechanical Engineers in annual meeting, a memorial tablet in honor of Calvin Winsor Rice was installed in the lobby of the Engineering Societies Building (*EE, Jan. '41, p. 48–9*).

Both the fund raising investigation committee and the committee to review pension plans have reported to the Board and action is pending. Other committees whose work has been most helpful are the committee for liberalizing the charter and the committee to investigate matters of mutual interest with the Engineers' Club.

Engineering Foundation Reports; Elects Officers

At the annual meeting of The Engineering Foundation, joint research agency of the Founder Societies, October 23, 1941, the following officers were re-elected for 1941–42: O. E. Buckley (M'19, F'29), chairman, F. F. Colcord, vice-chairman, and John H. R. Arms, secretary. E. H. Colpitts (M'11, F'12) was elected director. Members of the executive committee, in addition to the chairman, vice-chairman, and secretary of the Foundation are J. P. H. Perry, W. I. Slichter (A'00, F'12), and C. E. Stephens (M'22).

Members of the Foundation board for 1941–42, with dates at which term expires, are:

Trustees elected by the Board of Trustees of UET, Inc.

Condit, K. H., ASME, 1943
Stephens, C. E. (M'22) AIEE, 1943
Perry, J. P. H., ASCE, 1944
Queneau, A. L. J., AIME, 1945

Ex officio, President, UET, Inc.

Roberts, Albert

Members nominated by Founder Societies

Colcord, F. F., AIME, 1942
Ryder, E. M. T., ASCE, 1942
Farmer, F. M. (A'02, F'13) AIEE, 1943
Justin, J. D., ASCE, 1943
Potter, A. A., ASME, 1943
Barron, G. D., AIME, 1944
Fulweiler, W. H., ASME, 1944
Slichter, W. I. (A'00, F'20) AIEE, 1944

Members-at-large

Buckley, O. E. (M'19, F'29) AIEE, 1942
Dorr, J. V. N., AIME, 1943
Fish, Edwards R., ASME, 1943

Members of the research procedure committee are:

K. H. Condit, *chairman*	Sam Tour, AIME
E. M. T. Ryder	C. L. W. Trinks, ASME
H. E. Wessman, ASCE	L. W. Chubb (F'21) AIEE

Chairman Buckley was reappointed Foundation representative on the executive board of the National Research Council.

The personnel of other committees as appointed or reappointed at this meeting is as follows:

Iron Alloys

G. B. Waterhouse, *chairman and director*, professor of metallurgy, Massachusetts Institute of Technology, Cambridge, Mass., AIME

L. J. Briggs, director of National Bureau of Standards, represented by J. G. Thompson, chief of section on chemical metallurgy, National Bureau of Standards, Washington, D. C.

R. R. Sayers, director of United States Bureau of Mines, represented by R. S. Dean, chief engineer of metallurgical division, U. S. Bureau of Mines, Washington, D. C.

J. T. Mackenzie, metallurgist and chief chemist, American Cast Iron Pipe Company, Birmingham, Ala., American Foundrymen's Association

John Johnston, director of research, United States Steel Corporation, Kearny, N. J., American Iron and Steel Institute

J. H. Critchett, vice-president, Union Carbide and Carbon Research Laboratories, American Electrochemical Society

Bradley Stoughton, professor emeritus, Lehigh University, Bethlehem, Pa., American Society for Metals

Jerome Strauss, vice-president, Vanadium Corporation of America, Bridgeville, Pa., American Society for Testing Materials

T. H. Wickenden, assistant manager, development and research, International Nickel Company, New York, N. Y., Society of Automotive Engineers

Wilfred Sykes (A'09, F'14), president, Inland Steel Company, Chicago, Ill., member-at-large

Frank T. Sisco, *consultant*, assistant secretary, AIME, New York, N. Y.

John S. Marsh, editor, Iron Alloys Committee, The Engineering Foundation, New York, N. Y.

Welding Research

C. A. Adams(A'94, F'13), *chairman*, consulting engineer, E. G. Budd Mfg. Company, Philadelphia, Pa.

H. C. Boardman, *vice-chairman*, research engineer, Chicago Bridge and Iron Company, Chicago, Ill.

Everett Chapman, president, Lukenweld, Inc., Coatesville, Pa.

O. U. Cook, assistant manager, department of metallurgy, inspection and research, Tennessee Coal and Iron Railroad Company, Birmingham, Ala.

J. H. Critchett, vice-president, Union Carbide and Carbon Research Laboratories, Inc., New York, N. Y.

J. J. Crowe, assistant to vice-president and operating manager, Air Reduction Sales Company, New York, N. Y.

A. S. Douglass, construction engineer, Detroit Edison Company, Detroit, Mich.

C. L. Eksergian, chief engineer, Budd Wheel Company, Detroit, Mich.

A. J. Ely, mechanical engineer, Standard Oil Development Company, Elizabeth, N. J.

T. S. Fuller, works laboratory, General Electric Company, Schenectady, N. Y.

D. S. Jacobus (A'03), advisory engineer, Montclair, N. J.

G. F. Jenks, Colonel, Ordnance Department, United States Army, Washington, D. C.

F. H. Frankland, director of engineering, American Institute of Steel Construction, Inc., New York, N. Y.

A. E. Pew, Jr., vice-president, Sun Oil Company, Philadelphia, Pa.

A. C. Weigel, vice-president, Combustion Engineering Company, New York, N. Y.

A. R. Wilson, engineer of bridges and buildings, Pennsylvania Railroad, Philadelphia, Pa.

R. E. Zimmerman, vice-president, United States Steel Corporation of Delaware, Pittsburgh, Pa.

William Spraragen (A'17, M'26), *executive secretary* Welding Research Committee, The Engineering Foundation, New York, N. Y.

ANNUAL REPORT

The annual report of The Engineering Foundation for the year 1940–41 has been submitted to the AIEE and other participating societies by O. E. Buckley (M'19, F'29) chairman of the Foundation Board, and by United Engineering Trustees, Inc., of which the Foundation is one department.

The book value of the capital funds of the Foundation on September 30, 1941, was $977,000. Reduced income from investments, caused by lower prevailing interest rates, necessitated some restriction of expenditures.

The policy of making relatively small appropriations to a considerable number of projects in diverse fields of engineering was continued. In all cases these projects

had the approval of one or more of the Founder Societies, and in most cases they had additional support from societies or from industry. The Foundation has thus been able to promote research to a greater degree than would be possible were only its direct support involved.

During the year, work has progressed on 13 projects, comprising 34 separate problems. For the ensuing year, 16 formal applications for appropriations embodying 28 subjects were received and grants recommended for all but one.

The Foundation's director, Otis E. Hovey, who had served the Foundation since 1926 as a member of its board, and since 1937 as its Director, died April 15, 1941. A special committee of members of the Board selected as his successor Edwin H. Colpitts, who assumed directorship of The Engineering Foundation on October 1, 1941.

Summaries of the research projects sponsored by the Foundation with which the AIEE is directly concerned follow:

Stability of Impregnated-Paper Insulation. (Foundation grant, $2,000; AIEE $250; industry $2,500. Chairman, H. H. Race, General Electric Company, Schenectady, N. Y.; in charge of research, John B. Whitehead, Johns Hopkins University, Baltimore, Md.)

Work during the past year continued the studies of the influence of the physical properties of the constituents of impregnated paper, and the methods of assembly, on the behavior of thoroughly impregnated paper insulation with particular reference to dielectric strength, and physical and chemical stability under high stress.

The important influence of the density of the paper has been studied further with particular reference to a variation in the viscosity of the impregnating oil. It has been shown that the use of a heavier oil reveals the same behavior with a variation of the density of the paper on samples of the same construction as previously used; namely, a decrease of dielectric strength and stability with increasing paper density. Moreover, it has been found that the values of life and stability are definitely lower for the heavier than for the lighter oils.

This difference in behavior and values between the lighter and heavier oils has been studied further to determine whether the conditions of impregnation, with particular reference to oil viscosity, have any bearing on the results observed. To this end, the impregnating temperature was lowered for the light oil and raised for the heavier, so as to bring both to the same value of viscosity. The results indicated that within the range studied, temperature and viscosity have no influence on the dielectric strength and stability of the heavier oil. Lowering the viscosity of the lighter oil reduces somewhat the dielectric strength and stability of the assembled insulation, but not seriously as compared to the values obtaining in the use of the heavier oil.

Further studies have been made on the differences in behavior occasioned by varying the width of the oil channel of assembled, thoroughly impregnated cable-type insulation. The year has also seen the development of an important method for detecting the beginning of internal gaseous ionization in thoroughly impregnated laboratory samples.

Insulating Oils and Cable Saturants. (Foundation grant, $2,000; AIEE $250; other contributions, $10,630; the Massachusetts Institute of Technology provided services, equipment, and laboratory facilities equal in value to the financial assistance received. Chairman, Herman Halperin, Commonwealth Edison Company, Chicago, Ill.; in charge, Professor J. C. Balsbaugh, Massachusetts Institute of Technology, Cambridge, Mass.)

The main effort on this project in 1940–41 has been directed to the study of oil under limited oxidation conditions. This test is novel and promises to become an important tool in the study of insulating oils. A definite, predetermined amount of oxygen is placed in the deterioration system and the gaseous pressure is maintained with nitrogen, as the oxygen is consumed in reacting with the oil. In the usual industrial oxidation tests the oil is subjected to an unlimited supply of oxygen.

These studies led to the unexpected finding that the effect of limited oxidation upon the performance of oil is very different from the effect of unlimited oxidation. In particular, it has been found that the greatest amount of electrical deterioration is not produced by large or unlimited amounts of oxygen but rather by comparatively small amounts of the order of 8 per cent of oxygen of the oil volume. This finding is of particular practical importance as it shows that the greatest degree of electrical deterioration of oil is produced by amounts of oxygen of the order of magnitude which would occur in sealed electrical equipment filled with undegassed oil such as transformers. Dielectric losses of the oil are of some importance for transformers, and they are a vital factor in cable operation, both from an economic and from a technical viewpoint. These studies may lead to an explanation of the, so far, unsolved question as to the cause of increases in dielectric losses in cables sealed from the atmosphere.

In addition to oil samples prepared by the Gulf Research and Development Company and the Shell Oil Company, and commercial insulating oils supplied by the General Electric Company and the Sun Oil Company, studies were made on pure hydrocarbons, namely, cetane, cetene, decane, and decalin. The American Society for Testing Materials has submitted several oil samples for study in order to co-ordinate the results with the study of that organization.

In addition, the effects of other factors were studied, such as the effect of temperature and of the presence of paper and copper.

Welding Research Committee. (Foundation grant, $4,000; reappropriation $2,000; AIEE $250; other contributions $22,469. Chairman, Comfort A. Adams, E. G. Budd Manufacturing Company, Philadelphia, Pa.; Executive Secretary, William Spraragen, American Welding Society, New York, N. Y.)

During the year 1940–41 the work of the Welding Research Committee has become more closely geared to national defense needs. Some of the outstanding fundamental investigations which may be mentioned are: the study of heat flow problems; character and nature of residual stresses in welds, and what happens to them under service conditions; fundamentals of spot welding of aluminum and the lighter alloys; fatigue strength of welded joints; and resistance of welded joints to impact loads.

The Foundation's grant was allocated to the fundamental research division, which continues to stimulate welding research in our leading universities and has published a description of its method of operation and a large classified list of welding research problems needing solution. The universities are encouraged to select these problems for study and are assisted in a number of ways in furthering their investigations. Visits have been made by the officers, staff, and various members to the university laboratories, governmental departments, and industrial laboratories.

Reports and papers resulting from the activities of the Welding Research Committee have been voluminous.

The fundamental research division continues to make small grants to competent research workers. During the year it awarded a grant to J. T. Norton, Massachusetts Institute of Technology, for an X-ray investigation of residual stresses; another to G. E. Doan, Lehigh University, for the purchase of a heat-flow instrument; and also has continued to share one-half the cost of the research fellowship at Rensselaer Polytechnic Institute on the study of resistance welding.

The American Welding Society has continued its support by sharing a large portion of the cost of publication and distribution of the Committee's reports, and by giving over a large part of its annual meeting program as a forum for the presentation of reports of the research workers of the Committee.

Special Accounts. The Engineering Foundation is treasurer of seven accounts kept separate from that of the main Welding Research Committee. These are:

Carbon Steels Weldability Research Committee (organized May 1941)

High Alloy Steels Committee (organized March 1941)

Weld Stress Committee

Resistance Welding Committee

Aircraft Welding Subcommittee

Fatigue Testing (Structural) Committee

Structural Steel Welding Committee

The Foundation also reported for the year 1940–41 on the following projects which it is sponsoring:

Soil Mechanics and Foundation Division (ASCE, Foundation grant $6,000, other contributions $700)

Special Committee on Hydraulic Research (ASCE, Foundation grant $1,400, other contributions $1,000)

Alloys of Iron Research (AIME, Foundation grant $3,500, other contributions $9,259)

Internal Friction and Creep of Metals (AIME, Foundation grant $700)

Critical Pressure Steam Boilers (ASME, Foundation grant $1,000)

Fluid Meters (ASME, Foundation grant $2,000)

Rolling of Steel (ASME, Foundation grant $400)

Cottonseed processing (ASME, Foundation grant $500)

Engineers' Council for Professional Development (Foundation grant $4,500. See report in the December 1941 and previous issues of *Electrical Engineering*)

Plastic Flow of Concrete (Foundation grant $1,000). The Foundation has been assisting this research since 1930, but because of increased interest on the part of the Government and the concrete industry this assistance was no longer considered necessary and was terminated September 30, 1941.

LIBRARY • • • • • •

OPERATED jointly by the AIEE and the other Founder Societies, the Engineering Societies Library, 29 West 39th Street, New York, N. Y., offers a wide variety of services to members all over the world. Information about these services may be obtained on inquiry to the director.

Library Board and Officers Elected; Annual Report Issued

At the recent annual meeting of United Engineering Trustees, J. W. Laist was reappointed chairman of the board of the Engineering Societies Library for 1941–42 and W. A. Del Mar (A'06, F'20) vice-chairman. Harrison W. Craver was reappointed director of the Library and secretary of the board.

Members of the Library board appointed or reappointed for 1941–42 are:

Terms expiring October 1942

Thorndike Saville, ASCE
T. T. Read, AIME
William Shoudy, member-at-large

Terms expiring October 1943

C. E. Trout, ASCE
E. F. Church, Jr., ASME
W. S. Barstow (A'94, F'12)
W. D. B. Motter, Jr., member board of trustees UET

Terms expiring October 1944

J. K. Finch, ASCE
J. W. Laist, AIME
A. R. Mumford, ASME
W. A. Del Mar (A'06, F'20) AIEE
G. F. Felker, member-at-large

Terms expiring October 1945

A. T. Hastings, AIME
John Blizard, ASME
W. I. Slichter (A'00, F'20)
S. H. Ball, member-at-large

Ex Officio

G. T. Seabury, secretary, ASCE
A. B. Parsons, secretary, AIME
C. E. Davies, secretary, ASME
H. H. Henline, national secretary, AIEE
H. W. Craver, director, Library

Members of the executive committee for 1941–42 are:

W. S. Barstow (A'94, F'12)
E. F. Church
T. T. Read
J. K. Finch

ANNUAL REPORT

The annual report of the Engineering Societies Library for the year ending September 30, 1941, has been submitted to the AIEE and other Founder Societies by H. W. Craver, director of the Library and United Engineering Trustees. Essential substance of the report follows.

Libraries, in common with other institutions, are sensitive to unusual social and economic conditions. The extraordinary changes that are occurring in manufacturing and industry have resulted in constant appeals to the Engineering Societies Library for material on shipbuilding, the manufacture of munitions and aircraft, and on other subjects connected with the defense program.

As a means of making such information widely useful, the American Library Association requested the preparation of a brief, select list of books on defense topics which might serve as a guide to American public libraries. This list, "Engineering Defense Training", compiled with the assistance of the chief bibliographer, Harrison A. von Urff, was published in October 1940, and widely distributed.

The library has had 25,537 readers, and has served 10,259 users in other ways. Searches were supplied to 84 persons and translations to 52. For 2,646 persons there were made 24,752 photoprints and 31 microfilm copies. Books were lent to 474 members. Telephone requests numbered 5,274, and inquiries by mail were 1,698. In these various ways the library served 35,796 members and their firms, as compared with 40,576 in 1939–40. The reduction in visitors (4,644) accounted for most of the decrease. The absorption of many young men by the military forces and the intensified training given by the colleges have apparently affected the number of students using the library. There has also been considerable interruption of schemes of long-plan research work. The adoption of more liberal terms of loan to members has resulted in an increase of 120 per cent in the number assisted in this way.

Troubled times have had an effect upon acquisitions. The uncertainty of communications, the stoppage of publication in many countries of Europe, destruction in transit and, finally, the inability to transmit money, have all affected receipts from other lands. As a consequence, only 11,032 books and pamphlets were received as compared with 18,415 in the preceding year. Much of this material came as gifts and, as in other years, many gifts duplicated books already on the shelves, while others were not worthy of preservation. However, in spite of lessened receipts, the additions to the permanent collections were 5,900 books, pamphlets, and maps, a number slightly above that (5,716) of the year before.

Success in maintaining files of foreign periodicals has been gratifying. Receipts from Germany and the unoccupied lands have been fairly regular, although frequently much delayed. It is surmised that publication of many journals in the occupied lands has ceased, at least temporarily, but definite information cannot be obtained at present. The number of current periodicals received was 1,124.

During the year 486 new publications were reviewed by the staff in the journals of the Founder Societies and the Engineering Institute of Canada. These volumes included the best publications on engineering and the list published in the society journals called them to the attention of members in a convenient manner. The works have all been added to the library. Their market value, about $1,500, covered the expense of reviewing them. The library continues to benefit also by gifts received from members and other friends.

The permanent additions to the library consisted of 2,720 books, 160 maps, 3,001 pamphlets, and 19 searches, bringing the total stock to 152,263 books, 7,755 maps, and 4,492 searches, or 164,510 items. The number of titles (individual works) represented by this figure is 88,263.

Because the library is the constant recipient of gifts, it accumulates large numbers of duplicated volumes. Sales are made from this stock at every opportunity, but as storage space is limited and sales are infrequent, the stock from time to time becomes embarrassingly large. It was therefore decided, last fall, to offer to present certain portions of the collection to other libraries. Advantage was taken of this offer by a number of engineering colleges and libraries of local sections, to which some 3,500 volumes were presented. The duplicates on hand comprise 23,500 books and pamphlets. Receipts from sales during the year were $1,422.35.

Continued progress has been made in the classed index to periodical literature, to which approximately 20,000 cards were added, bringing the total entries to 256,000 articles published during the past 13 years. The arrangement of this material is that of the Universal Decimal classification, which is also used in the public catalog of the library facilitating simultaneous use of the two guides.

The budget appropriated for general operation was $48,400, of this amount $37,062.80 was provided by the Founder Societies on a membership basis as follows:

American Society of Civil Engineers	$ 9,840.20
American Institute of Mining and Metallurgical Engineers	7,885.10
American Society of Mechanical Engineers	9,265.40
American Institute of Electrical Engineers	10,072.10

Operation of Library

Maintenance revenue	$47,917.47	
Maintenance expenditures	45,763.72	
Credit balance for year 1940–41	2,153.75	
Credit balance from previous years	5,125.87	
Credit balance September 30, 1941		$ 7,279.62
Service Bureau revenue	9,281.71	
Service Bureau expenditures	7,426.40	
Credit balance for year 1940–41	1,855.31	
Credit balance from previous years	8,970.70	
Credit balance September 30, 1941		10,826.01
Total net operating credit balance cumulated to September 30, 1941		$18,105.63

Expenditures from this budget were $45,763.72 of which $7,764.30 was spent for books and other equipment of permanent value. The service bureau received $9,281.71 in payment for searches, translations, and copies, and spent $7,426.40. The year's operation of the Library is summarized in the accompanying tabulation.

The death, on May 30, 1941 of Arthur W. Berresford (A'94, F'14) is recorded with deep regret. Since 1935, Mr. Berresford had been an active member of the Library Board, representing the United Engineering Trustees, Inc., and during 1937 he was a member of the Executive Committee. A warm friend of the Library and deeply interested in its work, his counsel will be greatly missed.

HONORS

John Fritz Medal for 1942 Awarded to E. L. DeGolyer

The John Fritz Medal, joint award of the four national societies of civil, electrical, mechanical, and mining and metallurgical engineers, has been awarded for 1942 to Everette Lee DeGolyer, consulting petroleum engineer, Dallas, Tex., and deputy for conservation under the Federal Petroleum Co-ordinator for National Defense. The award is made in recognition of Doctor DeGolyer's pioneer work in the application of geophysical exploration to the search for oil fields, which has resulted in the development of vast new supplies. Presentation of the medal will be made at a dinner to be held in New York, N. Y., January 14, 1942, under the auspices of the American Institute of Mining and Metallurgical Engineers, of which Doctor DeGolyer is a past president.

A native (1886) of Greensburg, Kans., Doctor DeGolyer received the degree of bachelor of arts from the University of Oklahoma in 1911 and the honorary degree of doctor of science from the Colorado School of Mines in 1925. After three years with the United States Geological Survey, he entered the petroleum industry in 1909 as geologist for the Mexican Eagle Oil Corporation. From 1914 to 1919 he was in consulting practice. In 1919 he was active in forming the Amerada Corporation, with which he was associated until 1932 as vice-president and general manager, president, and chairman of the board. He was technical advisor on the NRA petroleum code in 1933, president of the Felmont Corporation 1934–39, and is now a member of the firm of DeGolyer, McNaughton, and McGhee, consulting petroleum engineers, Dallas, Tex. In 1940 he received the Lucas Gold Medal of the AIME, also for his achievements in the petroleum industry. He is also a past president of the American Association of Petroleum Geologists, and a member of the American Association for the Advancement of Science, Geological Society of America, American Petroleum Institute, British Institute of Petroleum, and other scientific and technical organizations.

Regarded as the highest honor of the engineering profession, the John Fritz Medal is awarded not oftener than once a year, without restriction as to nationality or sex, by a board composed of past presidents of the four Founder Societies. AIEE representatives on the present board are: F. Malcolm Farmer (A'02, F'13), W. H. Harrison (A'20, F'31), John C. Parker (A'04, F'12), R. W. Sorensen (A'07, F'19).

Eta Kappa Nu Award Winner Named for 1941

Doctor Cledo Brunetti, assistant professor of electrical engineering at Lehigh University, Bethlehem, Pa., and now on leave of absence for defense work at the Bureau of Standards in Washington, D. C., has been named by Eta Kappa Nu, honorary electrical engineering society, to receive its Recognition of Outstanding Young Electrical Engineers for 1941. Doctor Brunetti, the sixth man to receive this honor, was chosen from a large field of candidates nominated by heads of college electrical-engineering departments, personnel directors in the electrical industry, and AIEE Sections. Two Honorable Mention Awards have also been announced for 1941, and will be given to George F. Leydorf, staff engineer, Crosley Corporation, Cincinnati, Ohio, and Simon Ramo (A'40), advanced development engineer, General Electric Company, Schenectady, N. Y. A biographical sketch of Mr. Ramo appears on page 48 of this issue.

The awards were made by the following committee:

R. L. Sackett, dean emeritus, Pennsylvania State College, and chairman of the committee on student guidance and selection, Engineers Council for Professional Development, *chairman;* F. E. Brooks (A'38) chief engineer, Bronx-Westchester division, New York Telephone Company; Mark Eldredge (A'14, F'33) Office of Production Management, Washington, D. C.; R. E. Hellmund (A'03, F'13) chief engineer, Westinghouse Electric and Manufacturing Company; H. H. Henline (A'19, M'26) national secretary, AIEE; and E. F. Watson (A'19, M'30) teletypewriter engineer, Bell Telephone Laboratories.

The Eta Kappa Nu award, for young electrical engineers graduated not more than 10 years and less than 35 years of age, was inaugurated in 1936 to recognize "meritorious service in the interests of their fellow men." Particular attention is paid to all of the candidates' activities, technical, civic, social, and cultural.

The annual award dinner will be held in New York on Monday evening, January 26, the first day of the AIEE winter convention.

ASME Medals Awarded

Five medals were presented by The American Society of Mechanical Engineers at its annual dinner on December 3, 1941.

The ASME Medal for 1941 was awarded to Theodor von Karman, director of the Guggenheim Laboratory of the California Institute of Technology, Pasadena, and consultant of the materiel division of the United States Army Air Corps in recognition of "his brilliance as a teacher, his researches in elasticity and many fields of physics and mechanics, and his distinguished leadership in the fields of aerodynamics and aircraft design." The Medal is the highest award of the Society and is presented annually.

The Holley Medal was awarded to J. C. Garand of the Springfield Armory, Springfield, Mass., "for his invention and development of the semiautomatic rifle which bears his name and has been adopted by the United States Army, and is a distinct contribution to our national defense."

The 1941 Worcester Reed Warner Medal, awarded in recognition of outstanding contributions to permanent engineering literature, was given to R. V. Southwell, professor of engineering science, Oxford University, England, for many publications on aeronautics, theory of structures, elasticity, and hydrodynamics.

The Melville Medal was presented to R. V. Terry, assistant chief engineer of the Newport News (Va.) Shipbuilding and Drydock Company for his paper, "Development of the Automatic Adjustable-Blade-Type Propeller Turbine."

The Pi Tau Sigma Award, given for outstanding achievement within ten years after graduation from a mechanical-engineering course of a recognized American college or university, was presented to R. H. Norris, engineer in charge of the heat transfer section of the general engineering laboratory of the General Electric Company, Schenectady, N. Y., in recognition of outstanding work in the heat-transfer field.

OTHER SOCIETIES

NEMA Issues Standards

The National Electrical Manufacturers Association has announced publication of a new handbook entitled "Turbine Generator Recommended Practices", and a new edition of its "Large Air Circuit Breaker Standards."

The practices contained in the handbook on turbine generators were compiled to cover direct-connected sets and 25-cycle and d-c geared sets in types and sizes in current use. The material is divided into three classifications: turbine units, synchronous generators for steam-turbine drives, d-c generators for steam-turbine drives.

The new edition of the "Large Air Circuit Breaker Standards" supersedes the Association's publication No. 37-43. The new standard contains 30 pages of information, including commercial standards, general standards, definitions, and instructions for the installation, operation, and care of large air circuit breakers. It also contains application standards for large air circuit breakers and rating and manufacturing standards for both large air and enclosed air circuit breakers.

Copies of both publications are available

Future Meetings of Other Societies

American Chemical Society. April 20–24, 1942, Memphis, Tenn.

American Institute of Mining and Metallurgical Engineers. Annual meeting, February 9–12, 1942, New York, N. Y.

American Physical Society. 247th meeting, February 20–21, 1942, Detroit, Mich.

American Society for Testing Materials. Spring meeting, March 2–6, 1942, Cleveland, Ohio.

American Society of Civil Engineers. Annual meeting, January 21–23, 1942, New York, N. Y.

American Society of Heating and Ventilating Engineers. 48th annual meeting and seventh international heating and ventilating exposition, January 26–30, 1942, Philadelphia, Pa.

American Society of Mechanical Engineers. Spring meeting, March 23–25, 1942, Houston, Tex.

Canadian Electrical Association. January 19–20, 1942, Montreal, Que.

Engineering Institute of Canada. 56th annual and general professional meeting, February 5–6, 1942, Montreal, Que.

First Pan-American Congress of Mining Engineering and Geology. January 11–20, 1942, Santiago, Chile.

Institute of Aeronautical Sciences. 10th annual meeting, January 28–30, 1942, New York, N. Y.

Institute of Radio Engineers. Winter convention, January 12–14, 1942, New York, N. Y.

National Electrical Manufacturers Association. Midwinter meeting, February 16–20, 1942, Chicago, Ill.

from NEMA headquarters, 155 East 44th Street, New York, N. Y., at 75 cents per copy for "Large Air Circuit Breaker Standards", and 50 cents per copy for "Turbine Generator Recommended Practices."

Honorary Members Named by ASME

Honorary membership in the American Society of Mechanical Engineers was extended to five outstanding members of the society at its annual meeting, December 1–5 1941. They are: C. D. Howe, minister of munitions and supplies for Canada; Rear Admiral S. M. Robinson, chief of the Bureau of Ships, United States Navy; Major General C. M. Wesson, chief of ordnance, United States Army; L. P. Alford, chairman of the department of administrative engineering, New York University; Aurel Stodola, former professor of mechanical engineering, Swiss Technical University, Zurich. Victor Nef, consul general of Switzerland in New York, received the honor in behalf of Professor Stodola.

ASTM Standards on Electrical-Heating and Resistance Alloys. This new compilation issued by the American Society for Testing Materials gives all test methods and specifications developed through the work of ASTM's committee *B*-4 covering electrical-heating and electrical-resistance materials, thermostat metals, materials for lamps and radio tubes, and structural and electrical-resistor materials for furnaces. Standardized tests for electrical-resistance alloys cover resistivity, thermo-electric power, temperature resistance constants. For electrical-heating alloys there are tests on resistance change with temperature and accelerated life test. Short- and long-time high-temperature tension tests, and methods of determining linear expansion are among the tests for heat-resisting alloys. Seven standards cover materials for radio tubes and lamps and there are two specifications for electrical-heating alloys. Standard tests for thermostat metals are given. Copies of the 110-page publication can be obtained from ASTM headquarters, 260 South Broad Street, Philadelphia, Pa., at $1.25 per copy; discount on quantity orders.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers; publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Dual Rating of Electrical Apparatus

To the Editor:

In establishing a method of rating and in comparing various motors by their name-plate rating, it is necessary that each line of motors be considered separately. For the line of d-c motors used in severe-duty service, such as auxiliary steel-mill drives, the present practice is to rate the motors on a one-hour basis. That is to say, the motor is given a horsepower rating at which it can be loaded for one hour without exceeding the allowable temperature rise. This one-hour rating alone is not sufficient for applying the motor to a duty cycle, as it does not indicate the continuous thermal capacity of the motor with which we are primarily concerned.

In applying a d-c motor to a drive, we must first know whether the motor will deliver the required torque at the required speed. We must also know whether the motor has sufficient overload capacity to deliver the highest starting torque that might be encountered, as well as the highest running torque, both of which might be the result of abnormal operating conditions but nevertheless must be delivered. If the motor has these requirements as to torque ability, then we must know if the thermal capacity of the motor is sufficient to allow the continuous application of starting, running, and normal torque at certain intervals and for certain lengths of time to satisfy the cycle to be performed. Therefore, the name-plate rating should define the torque ability, the speed, and the continuous thermal capacity of the motor.

With the service-factor method of rating, this information would be shown or implied on the name plate and readily checked by reliable tests. If the service-factor-rating method be applied to this line of d-c motors, the nominal rating could be chosen as the present one-hour enclosed rating and a service factor applied to give the continuous rating.

Such a nominal horsepower and speed rating would not necessarily have a time rating associated with it, but would be an indication of the torque ability of the motor, since a fixed ratio will exist between nominal and starting torque and nominal and running torque. The nominal rating will also be useful in defining a speed for the motor at the nominal horsepower.

From the present Association of Iron and Steel Engineers standardized ratings, the ratio of starting and running torque to nominal torque is constant for all sizes of motors and would be as follows:

	Starting	Running
Series	5	4
Compound	4.5	3.5
Shunt	3.6	3

If recommended standards are to be adopted for defining the rating of a motor, we should also give careful consideration to the essential name-plate data and the method or methods by which this data can be proved by the manufacturer on a stand test. This proof is necessary as a protection to the customer.

Let us assume a rating as follows:

Nominal horsepower	50 horsepower
Nominal speed	525 rpm
Service factor	0.4
Temperature rise	75 degrees centigrade by thermometer
Voltage	230 volts
Winding	Compound
Enclosure	Totally enclosed
Ventilation	Natural

The foregoing information from the name plate tells us that the motor should have a speed of 525 rpm at 50 horsepower, 230 volts. From the 50 horsepower and 525 rpm the nominal torque would be 500 pound-feet. From the fixed ratio for this particular line of motors the maximum starting torque will be 2,250 pound feet and the maximum running torque will be 1,750 pound feet. From the service factor of 0.4 we know that the motor will rate 20 horsepower continuous for 75 degrees centigrade rise by thermometer. The name plate should state clearly the type of enclosure and ventilation if any, because a small amount of forced ventilation will

cause a large change in the service factor of a totally enclosed motor.

STAND TESTS TO PROVE NAME-PLATE RATING

The tests to be made might be classified as thermal, speed, and torque tests.

Thermal. A continuous heat run totally enclosed non-ventilated at 20 horsepower will have to be taken to see that the motor windings do not exceed 75 degrees centigrade rise by thermometer.

Speed. For the nominal horsepower and speed the motor must be run under load and rated voltage until approximate operating temperature is reached. (This check could be made immediately following thermal test.) The speed should be 525 rpm at 50 horsepower load. At this load good commutation should be obtained.

Torque. The maximum starting torque can be determined by means of a lever arm, one end of which is attached to the motor shaft and the other end on a set of scales.

The maximum running torque can be checked by coupling the motor to a dynamometer and measuring torque direct, or coupling it to a load machine and determining the torque from either input readings to the motor under test or from output readings to the load machine.

It is to be expected that the commutation at the maximum running torque will be inferior to that obtained at the nominal rating. However, it should be such that no damage to the commutator will result from periodic short applications of this torque load.

With nominal ratings of this kind the service factor would vary with the size of machine.

F. A. COMPTON, JR. (A '39)

(D-c armored-motor engineering department, General Electric Company, Erie, Pa.)

To the Editor:

In the recently issued "Report on General Principles for the Rating of Electrical Apparatus for Short-Time, Intermittent, or Varying Duty" (AIEE No. 1A) and also in an article on the same subject by P. L. Alger in the December 1941 issue of *Electrical Engineering* (pages 569–71) great stress is laid on the desirability of using the "service-factor or dual method of rating" in future standards. In view of this one may wonder how we got along without such a method in the past, when the fact of the matter is that we have been using the equivalent of this method for some time. In railway motors, for instance, we have used a combination of an hour rating and a continuous rating, both given in horsepower; in other types of motors, such as mill-type motors, we have used a combination of a short-time rating and information on the continuous-load capacity of the motors. The only reason why this method has not been standard for some of the small industrial motors is that in most fields where they are applied, little reliable information was available on the load characteristics and precalculation of an application was impossible. The common method employed was that of practical experimentation with standard motors having either short-time or continuous ratings. However, as better knowledge of the characteristics of various loads is acquired, there will be a greater demand for additional information that will make possible intelligent application of apparatus and also facilitate correct comparison between competitive products. It is therefore timely to discuss the best methods for giving more complete rating information than in the past wherever it is needed.

Personally, I would recommend as the preferred method that service-factor or dual method of rating which is obtained merely by adding to certain short-time ratings information on the continuous-load capacity, for the following reasons:

1. The rating of practically all electrical apparatus is now associated with temperature conditions for short-time or continuous operation, or both, and adherence to this practice will be more readily accepted than the adoption of an entirely new practice.

2. Manufacturers list and carry in stock apparatus based on short-time ratings, and it will be simpler and more economical to add to these ratings some information regarding the continuous capacities, and thus obtain a service-factor or dual method of rating, than to create an entirely new variety of apparatus.

3. The use of this particular service-factor or dual method alone instead of two methods as outlined in the report will greatly simplify the entire rating structure.

4. A combination of short-time and continuous ratings will make it possible intelligently to co-ordinate various pieces of apparatus in the same circuit. This is claimed to be one of the primary objectives of the report, but I can conceive of no way of generally accomplishing this objective with apparatus having widely different time constants except by giving a short-time rating with definite temperature limits in addition to the continuous rating.*

Another point in the report and article which deserves further scrutiny is the suggested method of selecting the nominal rating as a definite percentage of the maximum short-time load-carrying capacity. In many types of apparatus a large short-time load-carrying capacity represents no particular problem; in fact, it is difficult to avoid these capacities in slow-speed commutating machines or large two-pole induction motors. In these cases and also in others where it is difficult definitely to establish maximum load capacities, it would be unreasonable to assign a nominal rating as a function of the maximum capacity, especially if the nominal rating thus obtained were unsatisfactory from the viewpoint of other performance characteristics, such as power factor, efficiency, starting torque, regulation. The principal requirement in the assignment of a nominal rating for this method should be that the apparatus will operate at that rating for limited periods, preferably specified, and prove satisfactory from every point of view. This broad stipulation of course implies among other things that satisfactory minimum ratios of maximum-load capacity to rated-load capacity will be maintained for any given type of apparatus and application. Therefore careful consideration of these ratios is very important in all apparatus where the realization of large short-time load-carrying capacities represents one of the major design problems. Both the nominal and the continuous rating and their relation to each other also should be in accord with the requirements of typical loads to be carried.*

Aside from these points and a few others of minor importance, there is considerable merit in definite recognition of the service-factor or dual method of rating. The only question is: should the continuous rating be given as a ratio of the short-time rating or separately in terms of horsepower, kilowatts, or amperes? This is to some extent a question of personal opinion or preference, but Mr. Alger has pointed out some very good reasons for the use of a service factor. Furthermore, similar ratios are used extensively because they facilitate the establishment of uniform practices in commercial standardization of apparatus.

R. E. HELLMUND (A '05, F '13)

(Chief engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.)

(*Editor's Note:* See also Letter to the Editor by Thomas Carter on "Service-Factor Ratings," in the December 1941 issue, page 616.)

Improving Electric Service by High-Speed Switching

To the Editor:

The paper "Factors Contributing to Improving Electric Service by Means of High-Speed Switching and Utilization of Stored Energy," by J. T. Logan and J. H. Miles [*AIEE Transactions*, volume 60, 1941 (December section), pages 1012–16], is peculiarly interesting to me, because I have had the good fortune to participate in the discussion of these matters from the very earliest suggestion that perhaps breakers could be reclosed without any consciously added delay and perhaps motors would not slow down too much in the short time that zero voltage would exist. I remember making, at Logan's suggestion, a request to our factory engineers for a "time-delay push button" to prevent motor contactors from opening during this interval. That was a long time ago.

The point I have in mind is that these authors are owed a great deal of thanks from the industry for pioneering this idea. It may be that necessity was here again the mother of invention, because in this Southern area of vast distances and widely separated loads, it has always been necessary to find ways and means of improving service without resorting to the time-honored but expensive scheme of providing duplicate service.

In this paper a résumé of the whole situation is presented with evidence that the more special requirements of industry in this connection have continued to receive

*For further detail, see Classification and Co-ordination of Short-Time and Intermittent Ratings and Applications, R. E. Hellmund, *AIEE Transactions*, volume 60, 1941 (July section), pages 792–8.

the attention of these same engineers. In addition to pioneering they have persisted and developed the idea arranging to take care of the more difficult problems that attend instantaneous reclosing, and for this they are entitled to still more thanks from those who have made good use of the scheme.

It is not my intention to intimate that they have done this all alone. They would be the first to insist that many engineers have contributed to this development which is practically universally used now, ten years after its original trials. As a transplanted Yankee, with over 20 years of living in the South, I want to point to this excellent piece of work by our Southern engineers. It has never been ballyhooed as spectacular, but a little thought will convince any of you that it has had a profound influence on modern schemes for transmission and distribution.

E. H. BAILEY (A '18, M '40)

(District transformer specialist, General Electric Company, Atlanta, Ga.)

To the Editor:

The paper "Factors Contributing to Improving Electric Service by Means of High Speed Switching and Utilization of Stored Energy" by J. T. Logan and J. H. Miles [*AIEE Transactions*, volume 60, 1941 (December section), pages 1012–16] is particularly valuable because it represents the type of steps taken by utility engineers to advance the protective art for the purpose of providing improved electric service. All progress in this art depends upon the recognition of a problem, the determination of the field conditions, and analysis and specification of the main requirements. After these facts are available a satisfactory solution of a problem is usually very easy.

The authors have exhibited considerable ingenuity and realistic engineering in solving the problems described in the paper. This realism is evidenced by the fact that they have reached their conclusions after studying 15,000 breaker operations over a period of ten years. This type of field investigations and compilation of information should be very helpful to the manufacturing companies in producing apparatus that will help to advance the art of protecting and insuring adequate electric service.

S. L. GOLDSBOROUGH (A '24)

(Engineering department, Westinghouse Electric and Manufacturing Company, Newark, N. J.)

Voltage Calculation

To the Editor:

In the letter to the editor on "Voltage Calculation", by George P. Hobbs, in the November 1941 issue of *Electrical Engineering*, page 562, Mr. Hobbs is right in that the addition to the charge on a capacitor is by steps and that the potential difference across the terminals likewise increases by

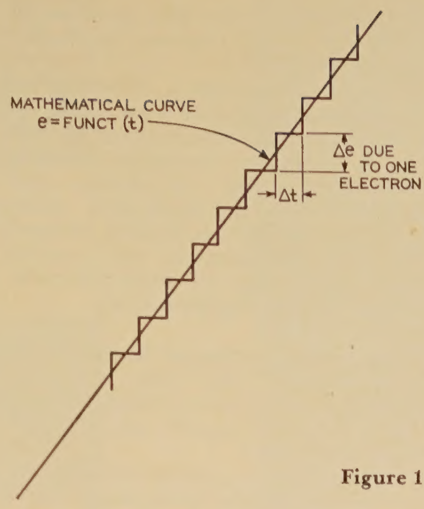


Figure 1

steps. If he will draw such a stepwise increasing curve, one riser for each electron added, then draw through the midpoints of all risers and steps a smooth curve, he will have the true relation of the real to the mathematical. It is only because the electrons are so very small and the resulting increments of potential difference correspondingly tiny that we are safely using the mathematical curve.

This is only one sample of the things found in engineering in which we safely use continuous mathematical expressions for things which we know do not strictly conform to mathematics.

ARTHUR BESSEY SMITH

(Chief research engineer, Associated Electric Laboratories, Inc., Chicago, Ill.)

Progress in the Art of Metering Electric Energy

To the Editor:

I have received the September 1941 issue of *Electrical Engineering*, and have read with interest the article on "Metering Electric Energy". However, may I draw your attention to the fact that one of the first of all electric prepayment meters was the Long-Schattner meter, patented in 1898?

In view of the substance of your magazine I think due acknowledgment of the existence of this meter should have been made.

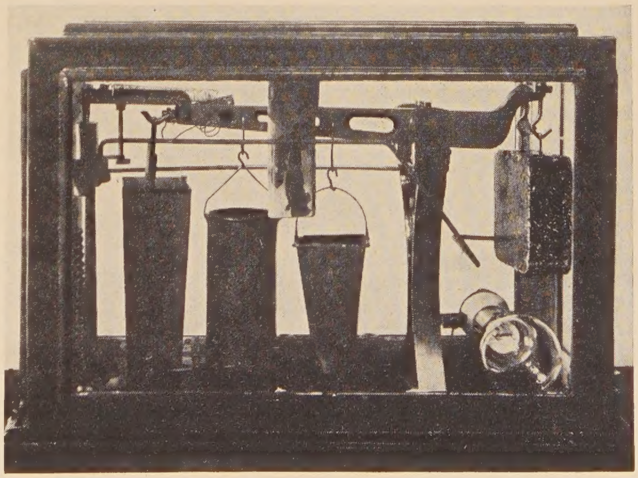
This electrolytic meter, patented by F. M. Long and E. Schattner, was actuated by a shunted portion of the current. The meter consisted of a lever mounted on knife edges and carrying two buckets, the anode plate of a copper electrolytic bath, and two contact pins all on one side of its fulcrum, and a weight on the other. Initially the weight was just able to depress its end jo the lever; consequently when a coin was placed in the slot which guided it into one of the buckets, its end of the lever was depressed. This caused the circuit to be completed and allowed current to flow until an amount of copper proportional to the weight of the coin inserted had been lost by the anode. The weight then again depressed its end of the lever, and, in the original form of the meter, the circuit was broken. In the example shown, however, to avoid the house being suddenly left in darkness, the circuit was never broken by the meter. Instead a high-resistance shunt circuit, generally in the form of a lamp, remained complete, so that a feeble glow would continue from every lamp left on; this reduced current passed through the cell, and its equivalent was therefore deducted from the supply given for the next coin inserted.

The electrolytic coil was shunted by a low-resistance coil, so that only a small fraction of the total current passed through it. The cathode consists of a copper vessel which, together with the anode plate, was renewed after recording 700 units; to prevent evaporation, the copper-sulphate solution had a layer of oil on its surface.

The meter was designed to take silver coins of the values threepence, sixpence, and a shilling, the weights of which are approximately proportional to their values. When the coins were removed by the collector, he placed equivalent standard weights in the second bucket; consequently the consumer did not ultimately suffer by the use of worn coins.

E. SCHATTNER (A '06, M '18)

(Co-inventor of the Long-Schattner prepayment meter; consulting electrical engineer, London England)



Long and Schattner prepayment ampere-hour meter, 1903 (Science Museum, South Kensington, London, England)

NEW BOOKS • • •

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

Electricity and Magnetism, Theory and Applications. By N. E. Gilbert. Revised edition. Macmillan Company, New York, 1941. 585 pages, diagrams, etc., 8 1/2 by 5 1/2 inches, cloth, $4.50.

Fundamental principles presented for nontechnical students, with illustrations from engineering and appliances in common use. Not intended as an introduction to electrical engineering or an exposition of the mathematical theory of electricity.

High Polymeric Reactions, Their Theory and Practice. (High Polymers, Volume 3.) By H. Mark and R. Raff, translated from the manuscript by L. H. Weissberger and I. P. Irany. Interscience Publishers, New York, 1941. 476 pages, diagrams, etc., 9 1/2 by 6 inches, cloth, $6.50.

Attempts to describe the present state of our knowledge concerning the mechanism of chemical processes during which high polymers are formed. In two parts: the general part presents important general relationships in a quantitative manner; the special part collects the literature on the subject, arranging the material according to the classification usual in organic chemistry.

Higher Mathematics for Engineers and Physicists. By I. S. Sokolnikoff and E. S. Sokolnikoff. Second edition. McGraw-Hill Book Company, New York and London, 1941. 587 pages, diagrams, etc., 9 1/2 by 6 inches, cloth, $4.50.

Aims to give students of engineering and other applied sciences a bird's-eye view of those mathematical topics beyond the elementary calculus which are indispensable in the study of physical sciences. Underlying principles are emphasized, rather than direct application to specific problems, so as to provide an introduction to advanced mathematical treatises. The new edition has been considerably revised and enlarged.

Industrial Accident Prevention, a Scientific Approach. By H. W. Heinrich. Second edition. McGraw-Hill Book Company, New York and London, 1941. 448 pages, illustrated, 8 1/2 by 5 1/2 inches, cloth, $3.00.

Essential principles and basic philosophy of accident prevention are presented, followed by an explanation of the practical application of these principles in industry, with further development and specific illustrative examples. Historical and statistical data are appended.

Industrial Instruments for Measurement and Control. (Chemical Engineering Series.) By T. J. Rhodes. McGraw-Hill Book Company, New York and London, 1941. 573 pages, diagrams, etc. 9 by 6 inches, cloth, $6.00.

Designed to provide a theoretical and practical treatment of the measurement and control of the four fundamental physical factors encountered in industrial processing and manufacturing: temperature, pressure, fluid flow, and liquid level. Automatically controlled continuous processes are thoroughly analyzed, and practical rules established for the design and maintenance of controlling instruments.

Introduction to Physical Statistics. By R. B. Lindsay. John Wiley and Sons, New York; Chapman and Hall, London, 1941. 306 pages, diagrams, etc., 9 1/2 by 6 inches, cloth, $3.75.

Intended for the graduate student who wishes a thorough but not too lengthy introduction to the method of statistical physics. Calls for a background of theoretical physics. A survey of the various ways in which statistical reasoning has been used in physics, from the classical applications to fluctuation phenomena, kinetic theory, and statistical mechanics, to the contemporary quantum mechanical statistics. Emphasis has been laid on methodology. Illustrative problems.

MacRae's Blue Book, 49th Annual Edition, 1941–42. MacRae's Blue Book Company, Chicago and New York, 1941. 3728 pages, illustrated, 11 by 8 inches, cloth, $15.00.

The new edition of this directory, following the plan of preceding ones, includes an alphabetical list of manufacturers, producers, and wholesalers, with the addresses of branch offices; a minutely classified list of products, with an extensive index; a list of towns of 1,000 or more population, with their trade facilities and railroad connections; and a list of trade names.

The Mechanism of the Electric Spark. By L. B. Loeb and J. M. Meek. Stanford University Press, Stanford University, Calif.; Humphrey Milford, Oxford University Press, London, 1941. 188 pages, illustrated, 9 1/2 by 6 inches, cloth, $3.50.

Analyzes the status of the theory of the mechanism of the electric spark in air at this time and, on the basis of this analysis, develops the streamer theory of spark discharge. The three chapters deal respectively with the Townsend theory of the spark, with the development of the streamer theory, and with the calculation of breakdown in various types of gaps. Bibliographies.

Municipal Affairs. By E. W. Steel. International Textbook Company, Scranton, Pa., 1941. 389 pages, diagrams, etc., 8 1/2 by 5 inches, cloth, $3.50.

Intended both as a textbook for college students and a source of information for those interested in municipal affairs. The first section is devoted to the development and forms of municipal government and its relation to state and federal authority. Administrative principles are treated in the latter part of the book, which includes discussions of departmental work and city financing methods.

Photomicrography. By R. M. Allen. D. Van Nostrand Company, New York, 1941. 365 pages, illustrated, 9 1/2 by 6 inches, cloth, $5.50.

Describes the process of photographing minute objects through a microscope, including essential information concerning microscopic technique for those unfamiliar with such work, although one emphasis is upon photographic equipment and methods. Examples of various kinds of photomicrography.

Principles of Electron Tubes. By H. J. Reich. McGraw-Hill Book Company, New York and London, 1941. 398 pages, illustrated, 9 1/2 by 6 inches, cloth, $3.50.

Essentially an abridgement of the author's "Theory and application of electron tubes", the present volume is designed for students not specializing in communication. New material includes a brief treatment of electron dynamics and an introductory treatment of frequency modulation.

The Reference Library of the Welding Research Council. Section I, Classified Library Catalogue, June 1941. Published by Institute of Welding, 2 Buckingham Palace Gardens, London, S.W.1, England. 136 pages, 8 1/2 by 5 1/2 inches, paper, 2s.

The major part of this publication is devoted to a catalogue of the reference library of the Welding Research Council, containing both author and subject entries in one alphabetical list. Additional information concerning the organization, staff, services, and publications of the Institute of Welding is also included.

Theory of Gaseous Conduction and Electronics. By F. A. Maxfield and R. R. Benedict. McGraw-Hill Book Company, New York and London, 1941. 483 pages, illustrated, 9 1/2 by 6 inches, cloth, $4.50.

The fundamental theory of high-vacuum electronic equipment is presented, with a systematic interpretation of the underlying phenomena upon which the properties of all types of gaseous-conduction devices depend. Covers not only high-vacuum conduction as found in electron tubes, but also the theory and application of corona, sparking, glows, and arcs.

Welding and Its Application. By B. E. Rossi. McGraw-Hill Book Company, New York and London, 1941. 343 pages, illustrated, 9 1/2 by 6 inches, cloth, $2.50.

Covers welding and cutting processes, with the emphasis on electric-arc welding, with their related phenomena, their techniques, and their general application in industry. Aims to present fundamental facts for the beginner, give the experienced operator a wider understanding of the welding process, and provide a source of reference for draftsmen, designers, engineers and any others interested in the subject.